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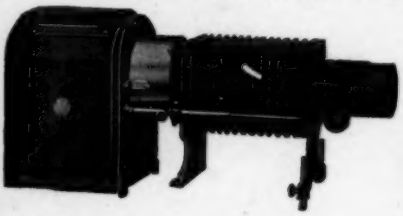

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XVIII[illegible] APRIL, 191[illegible] WHOLE NO. 150

REASONS FOR GIVING [illegible]GRAPHY A GREATER PLACE IN TH[illegible] SCHOOLS.[1]

By GEORGE D. HUBBARD,

Oberlin College, Oberlin, Ohio.

Introduction.—Let us be perfectly clear at the start that this discussion is based upon geography for the high schools, not upon such special phases thereof as physical or industrial geography. I look upon geography as (1) a study of locations and distributions of both human and environmental items and (2) a study of relations between the items of these two categories. In the words of another writer "Geography is the study of the mutual relations between man and his surroundings."[2]

When the emphasis is particularly upon locations and distributions, the work is especially memoriter. When the stress is laid upon the relations existing between form and form, or between forms and man, the work is more largely reasoning. Both phases are informational and both are disciplinary.

I agree with most of the teachers that pure physical geography or physiography is not at home in the high schools. It has been there because both the makers of textbooks and the teachers came to their geography by the geologic route and naturally emphasized that material most familiar. I also agree with my fellow-workers that industrial geography is too specialized to find a healthy atmosphere outside the technical high schools. Both subjects may be retained as electives in a high school, but they should not be considered substitutes for geography any more than bookkeeping should substitute for algebra or general science for physics and chemistry.

I have no apologies to offer for being here, nor for being the advocate in this case. I was delighted to be drafted for

[1]Read before the Earth Science Section Central Association at Columbus, Ohio, December 1, 1917.

[2]J. F. Chamberlain, *Jour. Geog.*, Vol. 5 (1906), p. 369.

this purpose, because I believe fully in geography, humanized and vitalized as it is today. I believe it can and should play a large part in secondary education. I am convinced that it has strong disciplinary value, and I am equally sure it has real cultural value. Add to these two its primary and obvious everyday utility and you see the main reasons why I believe teachers and geographers should be enthusiastically in favor of geography in the high schools. In preparation for this paper, I have used the German method of much thought on the subject, the French method of much reading, and the English method of much personal experience with the subject. I have borrowed freely from my contemporaries and I pass on to others just as freely. If I shall be able to make my case clear to most of us here, my appearance shall not be in vain.

I want in the space allotted me to set down some of the reasons for my convictions and beliefs stated above. These reasons may be grouped under the three subheads mentioned, utilitarian, disciplinary and cultural.

1. *Reasons Based upon Its Usefulness.*

Recognized as Fundamental in Grades and Advanced Studies.—In the words of Miss Kirchwey of Columbia: "Those who know the nature and value of the subject and the capacity of pupils are unable to understand why geography is so nearly limited to the elementary grades."[3] Dodge[4] and Whitbeck[5] both give expression to this idea in a different way. Dodge calls attention to the fact that pupils entering college are found short in geographical information and raises the question, "How can they help it, no matter how well they are taught, for they have had nothing, or very little, in this field for four or five or even six years before they enter college?"

That lost interval is one of rapid growth and adjustment, when the old is thoroughly displaced by new habits and methods of thought and by new attitudes toward life. We want the freshman in college and the high school graduate in business to be keen in English, mathematics and history, so we keep him at all three during the high school course. We deplore his ignorance of geography and yet we drop it out of his course after three or four years in the grades. What knowledge of English or mathematics would our people have at the college or business

[3] *Jour. Geog.*, Vol. 14, p. 291.
[4] *Jour. Geog.*, Vol. 5, p. 79; vol. 6, p. 102.
[5] *Jour. Geog.*, Vol. 14, p. 65.

door if they abandoned the subject when they left the seventh grade? Training in geography should begin in the grades and continue through the high schools as do mathematics, history and English, that pupils may know the subject when they graduate.

Those who study no regional geography after the grades are inadequately prepared either for further school work or for life. That this is true is attested on every quarter. Business men complain that the young people in their employ do not have geography when they come. Normal schools say their students do not have geography enough to take on the best thought and experience in methods of presenting the subject, so geography itself must be taught here before its pedagogy. The college teacher in every department notes the lack of geographic knowledge and training in his pupils.

Whitbeck raises the question: "Why is the study of geography made one of four or five fundamentals in elementaryschools of every enlightened land?" Its use and need are almost universal and it should rank as one of the fundamentals. Why is it dropped out years before the others go?

Teaches the Uses and Language of the Map.—Another phase of the utility grows out of the fact that geography's chief representative material is the map in which is condensed and recorded such a wealth of information not only geographic, but historic, economic, demographic, and political. Many a man in every walk of life has never learned the language of the map and all the world's knowledge stored in the various classes of maps is closed to him. "The ability to use maps and atlases and the habit of turning to them is one of the most valuable possessions which a course in geography can give."[6] It certainly seems unfortunate that so large a percentage of our men and women should be shut out of this treasure house because they do not know well its language.

Helps to Meet and Solve Daily Problems.—Another writer points out[7] that "no one can successfully cope with the world problems of trade and industry unless he has adequate knowledge of the various lands, their resources and development." A consideration of man's distribution and of his development and occupations in the different types of geographic conditions reveals abundant evidence of his ready response to intimate relation with the environmental conditions, climate, soil, relief and

[6]Chamberlain, J. F., *Jour. Geog.*, Vol. 5, p. 373.

resources. The needs of civilized man make requisitions upon all regions of the world. The more and better knowledge he has of these regions the better equipped he is to draw upon their varied resources. Shall the men and women of the next generation be able to meet successfully the great problems of life, industry, nationalism and internationalism? Then teach them as children and growing young people the value and distribution of resources, the relation of region to region as dependent upon national resources, climate and connections, the relation of people to people and product to product as determined by the geographic conditions. Teach them the inter-relations of nations and the interdependence of regions and let them come to realize that real "life is the establishing of equilibriums with the environment" as Herbert Spencer said. This emphasis is strongly placed in the Indianapolis course of study. Why not give the lad all possible help in understanding the environment and its relations to man; in linking himself up in a healthy, practical way with that which surrounds him and upon which he depends, and thus make it possible for him to live the largest, best and most civilized life?

Lincoln Hutchinson says:[8] "Man's very existence depends upon the geographical phenomena with which he is surrounded. Geography is an interpretation of these phenomena in the light of man's activities." Sutherland[9] points out that the history of nearly every localized industry shows it to be tied to its geographic factors of distribution, raw materials, markets, climate and labor, and that the "trend of industrial history is determined by geographic conditions." The best economists work on this conception. All trade and commerce is based on differences in resources and products. One should know a large body of these differences in resources and products to enter successfully into business competition. Such familiarity with geography helps one to see into the possibilities for his own country and the ways to meet the needs of his own nation or his own business, as well as indicating points of contact between his own and other nations. These points may or may not be developed. Many of these sentences are given added weight when one realizes that our young people, if they do as other generations have done, will soon be the established men and women of the land, and will have the large places in the world.

[7]Gulliver, F. P., *Jour. Geog.*, Vol. 5, p. 468.
[8]*Jour. Geog.*, Vol. 6 (1907), p. 127-8.
[9]Sutherland, W. J., *Jour. Geog.*, Vol. 5 (1906), p. 123.

What would it mean to the industrial, commercial, political, and professional development of our beloved land if everyone entering had a keen geographic vision, a good understanding of the significance and workings of these geographic factors! According to facts disclosed by the recently published draft figures, 1,000,000 men turn the age of twenty-one every year. Certainly as many pass eighteen, the age to graduate from high school. These men are in all walks and fortunes of life. But suppose each of these who went through high school, say a quarter million a year, received there a good, sound, geographic training, as good of its kind as that given him in mathematics and English. What a grip those young men could take on affairs! What a vision of the inter-relations and interdependence of men! How they could lead off in the affairs of men! Of what untold value their knowledge and power might be! Then suppose all of these men for twenty-five years actually did go through high school and really did receive such geographic training. Wouldn't America have a vision? And wouldn't American industry stand forth? But hush! It is a great dream! We can't do it now. Isn't it worth working for?

Geography Among Other High School Subjects.—There are other utilitarian values in geography. The New England Association of School Superintendents is responsible for the illumination shed by the following statement: "As a source of information valuable in itself and not merely as an instrument, it (geography) has no equal among its associate subjects."[10] The same group of teachers also urges that pupils "gain such knowledge about the earth and its inhabitants as shall make us know the world we live in, both as to the *land* on which are spread out the nations, and the *people* with their varied means of providing for their continual, essential and universal wants." It is particularly of its relation to other high school and college subjects that I want now to speak. A. T. Olmstead[11] says: "There is no science which has added more to a proper understanding of history than geography." Fenneman[12] says: "Regional geography of all phases of earth studies is best fitted to be a basis for entrance to college." And he further points out that it has a very valuable reflex influence on elementary geography; first, because so many high school graduates become grade teachers; second, because the high school pupils later

[10] *Bull. Am. Geog. Soc.*, Vol. 33 (1901), p. 441.
[11] *Jour. Geog.*, Vol. 10, p. 163.
[12] *Jour. Geog.*, Vol. 7 (1908-9), p. 156.

become school boards and intelligent members of the community. Geography is considered by some as preliminary and introductory to other sciences, by some as a synthesis of several subjects and hence competent to succeed them. It may be made either or both. Here are two excellent reasons for giving it in the high school. One argues for a Freshman treatment, the other for a Senior place.

I want to go farther in this matter of geography among its contemporaries in the secondary school curriculum. Its importance as the foundation and directing influence in the history of men and nations has already been stressed. National and racial as well as industrial history have been shaped by geographic conditions. No geography to illumine history in the high school means weaker and less effective history work. Closely related to history are civics and political economy, both of which are much better understood when interpreted with a geographic background. Why not teach the coming citizens to interpret each nationality in terms of its varying environment, with its limitations and possibilities, thus opening the way for appreciative and sympathetic brotherhood?

Botany and zoology always find their materials in certain geographic environment. If the course is to live, to be more than taxonomy, the geographic element is indispensable; and should the subjects take the very practical ecologic turn, the geographic at once comes to be uppermost. Literature and the foreign languages, Latin, German and French, fall far short of their inherent possibilities if not vitalized by uncovering wherever possible their geographic settings. Agriculture is a geographic subject, its distribution, methods, and success are distinctly dependent upon geographic (including climatic) conditions. One has but half his agriculture if he omits the geographic connections. Even the frills and trimmings of the high school program, most of them altogether practical, art, manual training, domestic science, and other hand work, should have their geographic contacts noted. From where do the materials come? Their qualities, prices, and utility are products of their places of origin, distance from market, and the conditions under which they are used.

Geography and College Subjects.—One has said: "Perhaps no study outside the mother tongue is vitally connected with so many college studies as geography."[13] Beginning with college

[13]Fenneman, N. M., *Jour. Geog.*, Vol. 7, p. 156.

geography, which should have the best possible elementary geographic foundation, those so connected are history, economics, sociology, political science, biologic science, agriculture in many of its phases, engineering, architecture, forestry and Bible.

Working out the relations a little farther, by quoting from a recent paper it may be said that "the physical features, climate, mineral and agricultural resources have furnished one motive in all history; topography, distribution of land and water, plain and mountain, valley and barrier, have been another; and the approachableness, proximity, or isolation of nations a third. While in most of ancient and medieval history, nations have concerned themselves with defense and military aggression, in the future they will be interested with the things that make for peace and mutual advancement. American, European and Oriental history are each intimately related to their respective lands; in fact, have been unfolded in specific localities under the influence of specific physical conditions.

The Oriental problem grows out of a chronic and aggravated case of geographic isolation, and breaking the isolation is already helping to solve the problem.

Race and immigration questions have to do with the sources and destinations of our immigrants, but that is not all. The character of the immigrant, the nature of his former home and his usefulness in the new are in large part geographic. He moves because of overcrowding or insufficient opportunity. He goes where physical opportunities seem to be greater. Transplanted, he finds new conditions and is uncomfortable and more or less a joke or a menace in the new place until adjusted.

Soils are a part of the physical environment to which geographic responses are made; hence a good understanding of geography will go a long way toward interpreting the soils. An appreciation of the geography of the various agricultural regions of the world would be an excellent basis for a study of comparative agriculture and would be an illuminant of the history of agriculture.

In summarizing the relations between geography and the subjects studied in colleges and universities it is sufficient to say this field is the meeting place of the physical and the human sciences. Their circles meet or overlap in geography and while each subject may contribute to the latter, each also draws from it fundamental material for further work in its own line.[14]

[14] *Educational Review*, 1908, pp. 388-90.

Helps to Interpret Human Affairs.—Dodge[15] says: "Geography is of value in the interpretation of human affairs, in making clear the story of the past and the conditions of the present." One does not need to study all of the data, theory, and philosophy, of the geography of every land to arrive at this value. This science lends itself admirably to the project or problem method as McMurray has indicated in his "Type Studies in Geography." In biology, we do not study all animals, not even all species, genera, families or orders. We select eight or ten types and study them in detail, then generalize. In geography, choose out many type countries, some of the first order as Great Britain, Russia, France, United States, Germany and China, and some of the second order as Austria-Hungary, Argentine, Brazil, Belgium, Holland, Japan, Italy, and study each intensively, then the minor countries could be used as outside reading to be compared and contrasted briefly with the types.

This geography will lead pupils to appreciate the physical, economic, and social causes underlying the consequences seen in human life. The youngster needs as a part of his equipment "a definite idea of the resources of his country, an idea of their value, distribution and relation to the various occupations, and to sense the fact that the life of a nation is due directly to its resources."[16] It will help him to understand the modern talk about conservation as nothing else perhaps can. Miss Henderson says on this point:[17] "Geography supplies a large share in training boys and girls into broad-minded, honest, sympathetic, clear thinking men and women, able to see plainly and to meet face to face the problems of national and private life . . . and to go about their solution in a sane, unprejudiced manner." And she adds at a later date: "When the great importance of wheat, iron and coal is clearly understood it is not hard to stimulate the thought that the producers (capitalist, boss, and laborer) are worthy of consideration; that their health, intelligence, and general comfort are important factors in the equation of production; and that conservation of exhaustible resources is a question of world-wide significance."[18]

Whitbeck,[19] speaking of geography in general and again of economic geography, puts it very suggestively. He says the "mission of geography is to give the broadest possible knowledge

[15]Dodge, R. E., *Jour. Geog.*, Vol. 14, pp. 282-3.
[16]Gregory, J. W., *Jour. Geog.*, Vol. 8, p. 113.
[17]*Jour. Geog.*, Vol. 8, p. 129.
[18]*Jour. Geog.*, Vol. 14, p. 98.
[19]Whitbeck, R. H., *Jour. Geog.*, Vol. 14, p. 70; Vol. 15, p. 233.

of peoples, countries and their cities, of their industries and achievements, and all that goes to make them weak or strong, leaders or followers among the nations of the earth and the principal reasons why these things are as they are." A year later he wrote, "it (economic geography) consists in part of the practice of sizing up the various relations of the world . . . in gaining an appreciation of their agricultural and mineral resources, the peculiar genius of the people, the strength or weakness of their governments, the efficiency of their education, their nearness to other countries whose trade is profitable, their access to the sea . . . and their defense against enemies . . . a sort of character study of the nations, it will (thus) be one of the most valuable studies in the curriculum. Every educated person desires this sort of knowledge." He further suggests, as an inspirational method of teaching, the use in review of a sort of score card upon which pupils could record their estimates of the various items in a nation's geography, nation after nation, so that they could be ranked or rated as are dairy animals or draft horses. A unique and capital idea.

2. *Reasons Based Upon Disciplinary Values.*—Geography shares with all the work of the schoolroom in the training of memory. From this point of view there is probably no more reason for teaching geography than any other subject. But the very fact that this subject is synthetic, that it brings together data from several fields, makes it of special value in other kinds of mental exercises. There is in every lesson the correlation of facts from different sources and the comparing and contrasting of countries, cities, conditions and results. Then there is the use of reference material, the taking of evidence, weighing, sifting, sorting and testing of evidence, the judging of values of influential factors in the growth of cities, industries and nations, and always the drawing of conclusions from facts observed or discovered on map or printed page. All this is of prime importance in developing the thinking and reasoning powers. Habits of observation and comparison, reasoning and judging, are just as valuable for the college student as for the business man who has never been to college.

A study of geography calls for the making of mental pictures. The home neighborhood can be observed and studied, then seen in map or picture. Then the map and picture of the distant scene is examined and the imagination fills the picture. I have heard lectures on foreign lands by men who have never seen the

lands themselves, lectures which were so true to the facts and so vivid that travelers who have visited those lands were sure the lecturer had seen all he told. The imagination had been trained to fill in consistent details and produce a true picture. The speaker was a geographer.

Geography lends itself admirably to the scientific method and to the problem or project method of instruction. It permits the setting of problems to be solved both out of doors and in the laboratory.

Education is designed to give both knowledge and power. The educated man has not only a well informed mind but a well trained mind. Geography, on previous pages, has been shown to be competent to furnish knowledge of an extremely valuable kind, knowledge that is not only life giving but life saving, knowledge that can be used every day, knowledge that cannot well be dispensed with. And now it appears also to be able to furnish training that gives power. It is no longer necessary to go over mental exercises in abstractions or with unusable data to get the discipline. One can get all the discipline necessary and at the same time become familiar with some of the most useful and most interesting data the world affords.

3. *Reasons Stated in Cultural Values.*—We come now to some of the more intangible but none the less real values derived from the study of geography. The students in this field have recognized the new, broader conceptions derived from geographic study, and teachers and parents have watched with interest the unfolding sympathy for and fellowship with other peoples as the knowledge of their geography grows. We feel very differently toward the Eskimo with his greasy, dirty skin when we come to appreciate the culinary, dietary and lavatory restrictions his meager, indifferent soil and uncongenial climate put upon him. And we can sympathize much better with the styles of dress and ornament, with the habits of labor and degrees of endurance common to the Central African when we become familiar with his geographic conditions.

Breadth of Outlook.—Some things we read and think about seem to restrict our vision and draw us back within ourselves. Not so with geography. Even if a man or woman never enters any occupation in which he can use his geographic knowledge and facility to make a living, he can see far more clearly than without the geography. This may be because it deals with people and their activities, the things the people are interested

in, or because it presents to one's mind the affairs of men, or possibly because it deals with objective things. How much more intelligently and broad-mindedly one reads his newspaper, magazine or summary of the world's doings for the week if he brings to his reading a knowledge of the people and places mentioned. How much better able he is to judge of the value of his news, or to estimate the effects of new turns in the politics and affairs of other nations. How much more these various campaigns of the last three years mean to the man or woman who knows about the countries being trampled over and war torn. The geography pupil has indeed a wider outlook than he who has no geography.

Geography Will Make World More Real.—Many people have little or no conception of any other part of the world than their own. In fact, a foreign land lacks reality. They are like the Virginia lad of fourteen who once went with his father on a business trip to the adjoining county and who on his return told his admiring schoolmates that if the world was as big the other way as it was the way he went, she was a buster. I once found a student in a normal school—I trust she was the only such one I ever had—who at the age of seventeen or eighteen confessed she had "never seen any of the surface of the earth." And I heard a bright girl in the fifth grade geography class say that "when ships, sailing the ocean, came to the equator, the passengers all had to get out and walk across and take another boat on the other side." It seems to me one must be fearfully cramped in his perception not to know these common things. Surely geography study will help wonderfully to make foreign lands living realities and the world a peopled home pulsating with familiar activities.

Depth of Interest.—One's interest in good things increases with his knowledge of them. Geography tends to socialize us all as it does the curriculum of which it is a part. It makes our conversation about things and affairs more interesting and intelligent. A man cannot well become self-centered if he has a working knowledge of the places and activities of the world, and of the life, feelings, inspirations and limitations of many groups of his fellow-men. His interests, too, will be broad. Intelligent, everyday, sane, healthy living demands geographic knowledge. And in turn this knowledge will give one lofty conceptions of life and some realization of his privileges and obligations among men.

Makes Sympathies More Cosmopolitan.—There seem to be people about us who have no sympathy or feeling of fellowship and kinship for any foreigner, but those of their own race, and I find that many of these unfortunates do not know much about the other fellows, know nothing of their geographic conditions, climatic limitations, handicaps of location, means of communication and travel, lack of resources and hindrances to development. I am sorry to have to state, but I believe it is true, that many a missionary to the Orient has done but small good because of lack of knowledge and sympathy. Geographic knowledge brings a pupil into close sympathetic touch with human life in every land, and thus becomes a powerful factor in true education and culture. Geography fraternalizes races and nations. It reveals the conditions under which the other fellow works and has developed, and thus helps us to understand him. His achievements look different in the new light, likewise his peculiarities. Miss Kirchwey believes "our geography or lack of it is largely responsible for our attitude toward other peoples."[20]

Geographic Knowledge Removes Prejudice.—Perhaps this point should have preceded the last, but it is certainly suggested by that and so may logically follow. In my early school days I found a geography which was then many years old. In it were picture maps. The map of Africa had in its central part a picture of men with tails, and that of Asia, men without heads, in Kamchatka and northern Siberia. It had many other strange and weird things in the *terra incognita*. Such a book developed my prejudice. I was terrified by some of the things, amused by others, but I did not care to call any of those deformed or misformed creatures my brethren. I never thought of any of them as having anything to do, as eating, climbing, becoming tired, searching for truth and aspiring to better things as I was doing. But later reading of more modern books dispelled my prejudice, partly by banishing my ignorance and partly by leading my imagination to right conceptions of what these far away lands really contained. I have a profound sympathy for men who can't get my point of view because their conditions have been so different. It is not the pupil's stupidity half as often as it is his environment that keeps him at the foot of his class. Another phase of this question comes to my mind. Some people today seem to be superstitious. One would almost think the thousands of years and scores of generations of ex-

[20] Kirchwey, C. B., *Jour. Geog.*, Vol. 14, p. 297.

perience would get it out of us. We are not only prejudiced against our fellows, but out of touch with the Infinite. We seem to be unable to comprehend Him and His relations to us. A friend of mine once said: "The pupil may discover through his geography lessons that adjustment to nature is valuable, that harmony with nature is as essential in the physical world as agreement with nature's God is in the spiritual world."[21] I wonder too if he might not learn the other truth, that if adjustment and harmony are so essential in the natural world how much more so they must be in the spiritual.

Stimulates Desire for Travel and Travel Reading.—It has been shown that good geography teaching gives a pupil the use of maps and atlases. It may also teach him the library habit for magazines, papers, reports, books and bibliographies; sources of information. It certainly will make reading more satisfying and intelligible. Even place geography can help in this item. Many a time my students have stopped after class or called at other periods to talk something over and have exclaimed, "How I would like to see this or that!" With the geographic knowledge, they want to see the country and people as well as the canvas and pillars. Some have to do their best to satisfy the wanderlust by reading travel books and descriptive matter; and several have actually found the means to gratify the desire for travel kindled in the geography classes.

Makes for Good Citizenship.—It has been said that "a knowledge of place and regional geography is what the average person, no matter in what walk in life, most needs." A committee on secondary school geography reported the above statement to the National Educational Association in 1909. The report continues: "Farmer, fruit grower, stockman, miner, promoter of railroads and waterways, manufacturer, shipper, fisherman, artisan, health-seeker and traveler all feel its daily need. One cannot read with intelligence the daily papers and periodicals, not to mention history, literature, politics and religion, without some considerable knowledge of regional geography. Familiarity with the geography of our own country and of Europe is a much-to-be-desired factor in good citizenship. Geography touches and broadens the daily life of every individual." However sweeping the above may be, it is certainly true that geography gives a more enlightened citizenship. Goode,[22] in speaking

[21]Sutherland, W. J., *Jour. Geog.*, Vol. 5 (1906), p. 126.
[22]Goode, J. P., *Jour. Geog.*, Vol. 15, p. 274.

of this regional knowledge of the resources and industrial achievements of peoples, said: "No other study offered in school or college is better adapted, when properly presented, to give an extensive acquaintance with the current history of the industrial world, and this in itself is a large element in a liberal education." I firmly believe there is no one subject so full of possibilities in promoting a healthy spirit among men, in opening one's eyes to the real situations in the regions of the world, in other words, in broadening, enlightening and vitalizing one's citizenship as geography."

If a student goes to college, I suppose one can excuse his high school work by saying "He will get it in college." But what about the ninety in a hundred who never attain to college, and the nine in ten going to college who, under an elective system, do not get geography there? This makes the call for good, clear, sane, abundant geography in the secondary school more imperative. Most of the young people must get it there if anywhere.

Professor Richard E. Dodge, President of the Association of American Geographers, says "Geography will come into its own when it is proved to be worth while."[23]

I trust my effort today will add a little to the proof that has been accumulating in recent years.

[23] *School and Society*, Vol. 3, pp. 253-4.

WAR SAVINGS.

"War Savings Stamps mark an epoch in our national life."—[Secretary of the Treasury McAdoo.

Many a successful business man has said that the saving of his first dollar was the most important single act of his life; that it marked the beginning of a habit and a course of conduct to which he attributed his success.

Something very analogous to this, it is believed, is going to be the effect on the American nation of the War Savings campaign. Not only are millions of individual citizens going to begin to save, but this habit of economy and saving is going to be a collective movement, a movement not of individuals alone but of the nation.

The habit of saving formed now has a deeper incentive than ordinary. We are saving now not alone for selfish reasons, we are saving now from patriotism, saving not alone for ourselves but for our country. The combination of patriotism and thrift is, indeed, going to make the War Savings campaign an epoch in our national life. It is not only going to be a thing of tremendous benefit to millions of citizens, it is going to be a thing of tremendous advantage to the nation as a whole, and affect our whole national life. It marks the beginning of a new era in American life, an era of economy, good sense, and patriotism.

A QUEER MISTAKE.

By G. A. MILLER,
University of Illinois.

Recently a teacher who was using the Stone-Millis Geometry as a text-book asked me where she could get some information in regard to the Egyptian unit of measure called "ruth," stating that her students became interested in a problem relating to the area of a triangle the lengths of the sides being expressed in terms of "ruths." I naturally did not recall having seen the term but we examined the tables of units of measure found in Eisenlohr's translation of the work of Ahmes without meeting any word which could reasonably be translated "ruths." The indexes of mathematical histories did not supply us with any clue relating to this term.

On looking over the problems in Eisenlohr's Commentary on Ahmes we found on page 125 the following problem: "Wenn dir gegeben ist ein Dreieck von Ruthen 10 an seinem Schenkel, Ruthen 4 an seiner Mündung (Basis). Was ist sein Flächeninhalt?" This problem furnished the key to the solution of the mystery. The authors of the Stone-Millis text-book had evidently failed to see, or followed one who failed to see that the German word "Ruthen" or "Ruten" means rods, and had written "ruths" instead of rods in their translation of this problem, found on page 199 of their *Elementary Geometry*, 1910. This note aims to save other teachers a similar embarrassment. The Egyptians had no unit of measure known as a "ruth."

It should be added that the same incorrect translation of the German word "Ruthen" appeared also in Cajori's *History of Elementary Mathematics*, 1896, page 44, and is repeated in the so-called "enlarged and revised edition" which appeared in 1917. In view of the popularity of this history it seems the more important that this correction should be given publicity, and the fact that the mistake involved is so obvious may perhaps be an element of interest to those who study the history of errors, especially since this error appeared also in other histories of mathematics.

SHORT METHODS IN MULTIPLICATION.

By ROBERT C. COLWELL,
Geneva College, Beaver Falls, Pa.

The multiplication of 111 by 111 gives at once 12,321; of 1111 by 1111 gives 1,234,321; 121 by 121 also gives a symmetrical form 14,641. The 1 of the unit's column comes immediately by multiplication; the 4 of the ten's columns by adding 2 plus 2. The 6 is the result of 2 times 2 plus 1 plus 1. The rest comes from symmetry. The product of 131 by 131 equals 17,161 is just as symmetrical, but the symmetry is hidden because 1 has been added to the 6 in the fourth place. Written $16161+1000=17161$ the symmetry is plain. All such numbers as 141, 151, 161, 191 may be squared in this fashion. This is a particular application of a much more general method of multiplication which might be called the algebraic method.

Just as

$$(ax+b)(cx+d) = acx^2+(bc+ad)x+bd,$$

so, 73×72 may be written:

$(7t+3u)(7t+2u)$ equals:

6.....	u
35	t
49	h
5256	

The addition may be performed mentally and the result written down at once. The position of the digit tells whether it is units, tens, hundreds, etc., so the multiplication may be carried on without the use of t or u. (With practice, this too becomes a mental operation.)

Thus: 211×328:

Units	1×8	$= 8$
Tens	$(2 \times 1) + (1 \times 8)$	$= 10$
Hundreds	$(2 \times 8) + (3 \times 1) + (2 \times 1)$	$= 21$
Thousands	$(2 \times 2) + (3 \times 1)$	$= 7$
Ten thousands	3×2	$= 6$
		69208

A COMPARATIVE STUDY OF CONGRUENT AND SIMILAR TRIANGLES.

By Robt. R. Goff,

B. M. C. Durfee High School, Fall River, Mass.

	A. Congruent Triangles.	B. Similar Triangles.
1.	Scalene triangles: angle, angle, side.	angle, angle.
2.	Scalene triangles: side, angle, side.	side, angle, side.
3.	Right triangles: side, acute angle.	acute angle.
4.	Right triangles: two arms.	two arms.
5.	Right triangles: arm, hypotenuse.	arm, hypotenuse.
6.	Scalene triangles: side, side, side.	side, side, side.
7.	The general case for all right triangles is: side, side or side, acute angle.	side, side or acute angle.
8.	Summary: The four methods of proving triangles congruent, covering all cases, are 1, 2, 6, and 7.	Summary: The four methods of proving triangles similar, covering all cases, are 1, 2, 6, and 7.

It will be noticed that: Where there are equal angles in congruent triangles, there are equal angles in similar triangles; where there are equal sides in congruent triangles, there are sides in proportion in similar triangles, except when only one pair of sides are equal in congruent triangles, and then there is no proportion in similar triangles.

The basic theorems in each group are 1 and 2 (although 2 can be made to depend upon 1, and in that case, only one is basic). These are proved by superposition. The other theorems in each group are proved by getting the conditions of one of the basic theorems, 1 or 2.

The method of proof for 3 in each group is 1.

The method of proof for 4 in each group is 2.

The method of proof for 5 in each group is adjacent position and 1, and in the proof of B, A is used.

The method of proof for 6 in each group is adjacent position and 1 (although the method of 6A can be 2); and in the proof of B, A is used.

The summary in each group consists of 1, 2, 6, and 7.

The principal use of congruent triangles is to prove lines or angles equal.

The principal use of similar triangles is to prove lines in proportion or angles equal.

THE CHEMISTRY TEACHER'S OPPORTUNITY.

By FRANK B. WADE,
Shortridge High School, Indianapolis.

My title might well have been "The Science Teacher's Opportunity" and it is only because I have perhaps considered more specifically the connection between the conditions brought about by the great war and the teaching of chemistry that I have taken the above as my title. You will all doubtless speedily apply to your own fields such general suggestions as I may be able to bring to you and the specific illustrations that I may select from chemical material will, I hope, serve to point the way to concrete application of these general principles.

In the present public emergency, the welfare of the country depends more than at any time in our past history upon the successful application of the principles of science to the solving of the problems thrust upon us by the war. It thus comes about that there falls upon the teachers of science a tremendous duty and a great opportunity.

As the public begins to realize and to appreciate more and more how dependent our modern civilization is upon the proper application of scientific knowledge, especially in time of war, there will come to us a larger and larger demand for efficient instruction in scientific subjects. We will be expected to give a proper start to the scientists of the future. With this demand, however, we may expect to find a certain lack of understanding of the length of time required to produce a real chemist or other scientist, and it will be one of our new duties to stand tactfully, but firmly, against any attempt to have us teach applications of chemical or other scientific principles before we have had time to teach the principles themselves.

We secondary school teachers will have all we can do to properly start our young scientists in the elementary principles of our sciences. If we can lay sure foundations, the colleges and technical schools will attend to the further progress of the student. Some of us have perhaps devoted rather too much time in the past to what we thought were practical applications, and too little time to the real solid foundations; and in consequence it is undeniable that many college teachers would rather themselves start students in the special sciences than have us do it for them.

We must correct this condition by giving our pupils thorough drill in all the fundamentals of our subjects and by training them to think chemically or physically, as the case may be; and then these college men will gladly accept the help we can give them in getting science students rightly started. We have more time than the college teacher and a better chance to get at the individual pupil and if we go about our task intelligently, we should be better able than the college man to teach the beginnings of the science courses.

The early recognition of the pupil who is adapted to follow a scientific career and the encouragement of that type of pupil to elect further science courses will be, to a greater extent than ever before, one of our duties and privileges.

Up to this point in my discussion I have spoken as though the preparation of pupils for actual scientific work were the all important matter in secondary science teaching. Really, however, while we will probably be called upon to start more pupils than formerly in scientific careers, the actual numbers so started by any of us will still be very small when compared to the numbers of pupils who will take our science courses with other ends in view. All men cannot be scientists. While this would be a pretty poor world were it without any scientists and a rather better one if we had a few more of them who could get what we now know into general use, yet I suspect that too many scientists might prove almost as bad as too few.

It will thus be necessary for us to provide suitable instruction for the ninety per cent or so of our pupils who will probably never become scientific men. Our principal business in life ought to be to find out just what we can and ought to give these pupils in the present crisis in order to best fit them to cope with the many problems that are upon us as men and women rather than as scientists.

The crying need of the times is clearly brought out by a recent letter from President Wilson's pen. The letter was addressed to "School Officers." It reads as follows:

> The war is bringing to the minds of our people a new appreciation of the problems of national life, and a deeper understanding of the meaning and aims of democracy. Matters which heretofore have seemed commonplace and trivial are seen in a truer light. The urgent demand for the production and proper distribution of food and other national resources has made us aware of the close dependence of individual on individual and nation on nation. The effort to keep up social and industrial organizations in spite of the withdrawal of men for the army has revealed the extent to which modern life has become complex and specialized.

These and other lessons of the war must be learned quickly if we are intelligently and successfully to defend our institutions. When the war is over we must apply the wisdom which we have acquired in purging and ennobling the life of the world.

In these vital tasks of acquiring a broader view of human possibilities the common school must have a large part. I urge that teachers and other school officers increase materially the time and attention devoted to instruction bearing directly on the problems of community and national life.

Such a plea is in no way foreign to the spirit of American public education or of existing practices. Nor is it a plea for a temporary enlargement of the school program appropriate merely to the period of the war. It is a plea for a realization in public education of the new emphasis which the war has given to the ideals of democracy and to the broader conceptions of national life.

In order that there may be definite material at hand with which the schools may at once expand their teaching I have asked Mr. Hoover and Commissioner Claxton to organize the proper agencies for the preparation and distribution of suitable lessons for the elementary grades and for the high school classes.

Lessons thus suggested will serve the double purpose of illustrating in a concrete way what can be undertaken in the schools and of stimulating teachers in all parts of the country to formulate new and appropriate materials drawn directly from the communities in which they live.

WOODROW WILSON.

It is the need for the formulation of such new and appropriate materials drawn from the subject matter of chemistry that chiefly interests me at this time. This material must have a bearing on current problems of individual, of community and of national life. We must first teach the underlying principles to the mass of the class as well as to those who are to become scientists; then we must hunt out and bring before them the relations of these principles to current problems. In so far as it is possible, our illustrations and our experiments should be derived from or applied to such problems. We should also bring to our classes information as to what has been done and is being done by practical scientists toward solving the real problems of the country and of the people.

If we can thus make our pupils intelligent as to the need for and the uses of science, we shall be doing them a real service of a very practical nature, far more practical indeed than any service we can render them in the way of so-called practical applications of half-learned principles.

Having now stated my thesis, may I not take a few more minutes of your time to suggest in concrete fashion how a chemistry teacher can act upon my suggestions in a few specific instances.

Let us consider the problem of fuel conservation. While our fuel administration battles as best it can with the problems of supply and demand, and of transportation, what can we chemistry teachers do toward helping our pupils and their

parents and our communities to a real saving of fuel? Can we not, at about this time in our courses, having made clear to our students the principles underlying ordinary combustion, show them by experiment and by visits to manufacturing plants that the escape of smoke can and should be largely prevented, especially in large establishments? Can we not show them that destructive distillation is bound to follow the heating of soft coal—that it does not follow the heating of coke or charcoal or anthracite coal; that the first two of these last three fuels have certainly, and that the last has probably already undergone destructive distillation and cannot repeat, and hence that they are not smoke producing? Can we not take our pupils to the gas works where "smoke production," if we may call it that, is the principal source of revenue, and show them how the smoky products are condensed and separated to be sold? They can then profitably visit a modern boiler plant having automatic stokers to regulate the rate of feed of the fuel and hence to limit the destructive distillation, so that relatively small quantities of volatile products are produced per minute. The Dutch ovens or other means for superheating the smoky products, so that they will be sure to be kindled and kept above their kindling points until combustion is complete, will next be shown and the method in use at the particular plant for supplying adequate quantities of fresh air to the fuel will be pointed out. By opening the furnaces at the proper point, the class can be shown that the products of combustion are colorless and transparent, indicating complete burning of the valuable fuel supplied to the furnaces.

Such a trip can be followed by some discussion as to ways and means of at least reducing the amount of smoke from domestic heating devices, although it must be confessed that here we encounter an unsolved problem for our future scientists to cope with. If all our pupils, and through them their parents, hear of what can be and even now is being done in the way of successful smoke prevention, and especially if we succeed in impressing upon them not only the enormous waste involved in the loss of volatile fuel material but also the very great direct financial gain that should and can result from the installation of proper devices for prevention, we shall have done a very practical and serviceable thing.

If, in addition, a little newspaper publicity is obtained for this sort of work, an even larger usefulness may result. Most

papers would welcome a well written article from the teacher, in which the need of the country for fuel conservation was briefly alluded to and a modest claim made for the great saving that proper combustion might make. This could then be followed by a section in which the conditions necessary for proper combustion were set forth in simple language, and then one or two of the most successful types of smoke prevention devices could be briefly described and pictured by means of simple diagrams. Such an article would find a welcome in many a Sunday edition of even the large city papers.

There are many other topics treated in general chemistry which could be similarly connected with the needs of the country. I shall mention but one more and that is the conservation of food by preserving, drying, canning, smoking, salting, and the use of a chemical preservative, or by refrigeration. At the time that decay is studied, perhaps in connection with oxidation and combustion, we have a fine opportunity to show why each of the above methods is effective and it may even be worth while, if the season permits, to segregate the girls for a few days and to give actual instruction in home canning. We have a steam cooker in my own department, and gave the girls a short but thorough course last spring in the principles and practice of canning. Up-to-date methods were taught and some fine canned goods were produced under the instruction of Miss Garber, of my department.

The second part of my thesis, and the final part for the present, deals with the bringing before our pupils of information as to the big things that have been done by American chemists since the war began. You will at once think of the progress that has been made in the production of synthetic dyes and of the more than $170,000,000 that has been invested in the American dye industry. Another big thing, also, that is being done, and one that can perhaps be better explained to elementary pupils, is the extensive fixation of atmospheric nitrogen, that has been undertaken by the Federal Government. At the time you are studying the atmosphere, and have called attention to the seeming inactivity of its nitrogen, you can bring in some account of this great chemical industry that is of such vital importance in war times and scarcely less important in times of peace.

I will not take your time to review recent progress in methods of nitrogen fixation, but rather refer those of you who may

wish to prepare material for class use to the excellent synopsis of the several practical methods given by Chas. L. Parsons of the Department of Chemistry of the Bureau of Mines in the *Journal of Industrial and Engineering Chemistry*, the September number, 1917.

Mr. Parsons visited Europe to study the question for the U. S. Government and he gives a splendid account of the various processes, with discussion of the advantages and disadvantages of each, and concludes by making recommendations as to the use of the $20,000,000 appropriation authorized by Congress for the fixation of nitrogen.

Or see "Fixation of Atmospheric Nitrogen" by Joseph Knox, D. Van Nostrand Co., 1914.

To sum up my suggestions briefly—let us as science teachers prepare to give thorough training in the fundamental principles of our sciences to a rather larger number than usual of candidates for a scientific career. Let us, however, at the same time draw our illustration from, and apply our principles as far as is possible to, current scientific work with a special view to helping in a small way to solve some of the vexing problems forced upon us by the war and to instruct our pupils as to what is being done for them and for us all by applied science.

It is only thus that we can answer successfully to the call of the hour and "do our bit" toward meeting the needs of our communities and of our country.

WIRELESS TIME SERVICE IN THE PHILIPPINE ISLANDS.

The progress in the time service of the Philippine Islands is made evident from the fact that since October 1, 1917, the Cavite Radio Station, cooperating with the Bureau of Posts and the Manila Observatory, sends out time signals of the 120th meridian east of Greenwich at 11 a. m. and 10 p. m. every day, Sundays and holidays inclusive. Manila holds an enviable portion in the Pacific and the interests of shipping companies making Manila a port of call are too important to be overlooked. Accurate time signals and wise typhoon warnings are of immense value to the units of the United States Asiatic fleet, to army transports and in general to oversea shipping.

For the purpose of sending time signals, the transmitting clock of the Manila Observatory is connected with the Cavite Wireless Station through the Bureau of Posts. Manila Observatory time signals begin at 10:55 a. m. and 9:55 p. m. standard time of the 120th meridian east of Greenwich, and continue for five minutes. During this interval every tick of the clock is transmitted, except the 28th, 29th, 54th, 55th, 56th, 57th, 58th and 59th of each minute. Experiments made on board the U. S. Wilmington, Monterey, Sheridan, Merrit and the commercial steamer Colombia of the Pacific Mail gave satisfactory results.—M. Selga in *Popular Astronomy*.

VALID AIMS AND PURPOSES FOR THE STUDY OF MATHEMATICS IN SECONDARY SCHOOLS.

By ALFRED DAVIS,
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Chairman of a Committee of the Mathematics Club of Chicago Appointed to Investigate This Topic.

(Continued from March number)

PART III.

If we are to realize our aims and purposes in the teaching of mathematics it may be necessary, as times and conditions change, to vary both subject matter and methods of teaching it. However, such change is evidence of life, not of death.

The New England Report, already referred to, says, "Some teachers of mathematics in the high schools are inadequately prepared for their work, perhaps teaching it only incidentally. Conditions in normal and grammer schools are probably worse." Matthew Arnold says, "The plan of employing teachers whose attainments do not rise far above the level of the attainments of their scholars has been tried and it has failed." By far too much emphasis is put on methods in schools of education for prospective teachers when these would-be teachers have not thoroughly mastered the subjects they seek to teach. Not that any teacher can know too well how to teach, but the study *about* education should never be at the expense of education itself. The scholarship requirements for teachers should be higher than they are; indeed, we can scarcely make them too high; for superior scholarship in the subject one is to teach is of supreme importance, and all of us would be happier with greater efficiency in our chosen field. Much of the criticism of mathematics today is from those who are perfectly well informed as to how it ought to be taught, but they have little knowledge—and less appreciation—of the subject. Prof. L. T. More (*Nation,* May 3, 1917) says, "A few months in a schoolroom acting as an assistant to an experienced teacher after a sound college course will prepare a person for teaching more effectively than pedagogical courses." The plan is worth thinking about.

On the other hand, granting adequate scholarship, all who enter the teaching profession need technical training in teaching, more than most of them get at present. Knowledge of a subject does not necessarily imply ability to teach it; it is frequently assumed that it does, but some brilliant students have made

very poor teachers. It is a crime to make the classroom a laboratory in which the would-be teacher shall try by hit-and-miss efforts to gain experience. Doctors of medicine do not gain all their preparation by experimenting on the helpless sick. Lawyers are not entrusted with our reputations before they have earned to practice law. The teacher in training should be under the direction of an expert. Our material, the plastic minds of boys and girls, is too valuable to be trifled with. Besides, we have too much at stake in the reputation of our subject to take such chances. The teacher must learn to see the subject from the pupil's angle and to present it effectively; to accomplish this he must, while practicing under an expert, master the fundamentals of psychology and of pedagogy. Above all, the teacher's preparation should draw out his individuality, the thing that makes him different from every other teacher; and it should enable him to avoid the ruts from the beginning.

Much of the inability of students to master mathematics is due to poor teaching at some point in their career. Those who cannot master a reasonable amount of mathematics are probably no more numerous than physical defectives. Someone has said that algebra is "fool proof," and this has been assumed true by many principals in assigning work to teachers. Dr. Snedden, ("Problems of Secondary Education," p. 225) says, "Algebra is one of the easiest of secondary school subjects to teach with a certain degree of apparent effectiveness. Lessons and hard tasks can be assigned easily, and a very duffer of a teacher can make pupils work slavishly on this subject. In most small high schools today it will be found that the teacher with least special preparation for his work is usually teaching algebra. The case here is somewhat analogous to the practice of 'electric' and 'magnetic' healing by 'near' physicians." This is a somewhat frank statement that the trouble with secondary mathematics is not with the subject but with the teaching of it. Poor teaching gives a subject the reputation of being difficult. When pupils pass the word along that algebra or geometry is hard and uninteresting the battle is lost before it is begun. Even a good teacher will have difficulty in overcoming this prejudice.

Another source of trouble is the assumption that when a pupil masters a principle this guarantees his ability to use it. Such is not the case. Many of our best students appear sadly inefficient when they leave high school. Application is quite

as important a part of our work as the teaching of principles. Of what value is a tool unless we are taught the actual use of it? Prof. Judd ("The Psychology of High School Subjects," p. 130) says, "It is contrary to experience to assume that students can apply mathematics to the other sciences or to the practical affairs of life unless they are trained to see mathematical relations in other forms than those in which they are commonly presented in the schools. The student who knows the abstract demonstrations of geometry, but does not realize that knowledge of space is involved in every manufacturing operation, in every adjustment of agriculture and practical mechanics, is only half trained. Application must be a phase, and an explicit phase, of school work. Application is as different from pure science as pure sciences are different from each other."

In addition to the inefficiency of teachers we have the inefficiency of students as such. This is probably due to two causes. First, the idea is somewhat prevalent in the elementary schools that a pupil may gain an education by being amused. He is not trained to feel nor to know personal responsibility. His education is entirely a matter for the teacher to look after. He even resents any attempt to secure his initiative if the effort he is to make savors of drudgery or requires hard thinking. School work must be a pleasure and without responsibility. Second, there is a tendency on the part of college students to ignore study. This spirit finds its way into the high school, which so often tries to imitate the college. Consequently, many who could be good students fail; mathematics, requiring the sort of effort they know nothing about, is impossible with them. Ability in mathematics may, usually, be considered synonymous with ability to be a good student. Prof. Schultze ("Teaching of Mathematics in Secondary Schools," p. 25) says, "It is a common experience to see a pupil in the upper grades suddenly wake up to the meaning of mathematics and thereby change his attitude towards study in general." A good standing in high school is almost certain to guarantee a good college record and a successful life. This matter has been splendidly treated by Wm. T. Foster, President of Reed College, Portland, Oregon, in "Should Students Study" (*Harper's Monthly*, September, 1916). He raises the question, "Are good students in high school more likely than others to become good students in college?" Three colleges in as many states are considered. Of hundreds of students in the University of Wisconsin, above

80 per cent of those in the first quarter in the high school remained in the upper half of their classes throughout the four years of their university course, and above 80 per cent of those who were in the lowest quarter in high school did not rise above mediocre scholarship in the university. Only one in five hundred of those in the lowest quarter reached highest rank in the university. The University of Chicago found that students that failed to receive in high school an average higher than pass by at least one-fourth of the difference between the passing mark and 100 per cent failed in college; such students are, therefore, not admitted; where exceptions are made the record in college is seldom satisfactory. Reed College, at its fall opening five years ago, admitted only those students who ranked in the first third in the preparatory schools: about 20 per cent were exceptions to this rule and 2 per cent were below the median line; these exceptions were selected as the best below the first third. Of these exceptions, practically none rose above the lowest quarter in their college classes. The same results are shown to be true of those who go from college to the professional schools. Surely "promise in high school becomes performance in college," and the mediocre in high school are out of the race. President Foster says, "If all these studies prove anything, they prove that there is a long chain of causal connections binding together the achievements of a man's life and explaining the success of a given moment. . . . Luck is about as likely to strike a man as lightning and about as likely to do him any good. The best luck a young man can have is the firm conviction that there is no such thing as luck and that he will gain in life just about what he deserves and nor more. . . . At a convention of teachers not long ago a speaker ridiculed a German boy who, upon failing in a recitation, put his head upon his desk and cried. He said he had never seen such a boy in the schools of this country. . . . Nothing seems to promise failure in the tasks of tomorrow with greater certainty than failure in the studies of today. . . . Among teachers the greatest number of criminals are not those who kill their young charges with overwork, but those who allow them to form the habit of being satisfied with less than the very best there is in them."

From a study by President Lowell, of Harvard (*Educational Review*, October, 1911), it appears that President Foster's conclusions apply to Harvard students. Of 609 who graduated

from college with A. B. plain, only 6.6 per cent obtained cum laudi in Law School. Students of mathematics attained highest honors in Law School. Students of classics stood next. The qualities of diligence, perseverance, and intensity of application acquired in the study of mathematics secured a higher degree of success than was obtained by others. The pupil should be impressed with the importance of proper habits of study and he should be aided in forming these habits. If he finds the work very hard, let him profit by the determination of Robert Bruce as he watched the spider, after many futile efforts, finally reach the ceiling. If he is inclined to waste time let him get inspiration from the words of Hotspur before the battle of Shrewsbury:

> "Oh, gentlemen, the time of life is short;
> To spend that shortness basely were too long,
> If life did ride upon a dial's point,
> Still ending at the arrival on an hour."

The New England Report says, "There is real danger that depreciation of mathematics by persons supposed to be experts in matters of secondary education may, unless vigorously met, exert an unfavorable and undue influence on public opinion." It would seem desirable that teachers of mathematics assert their claims more energetically, for it is not always safe to assume that right will win without an advocate. It is not necessary to enumerate these criticisms; we are all familiar with them. Some have been justified and have already resulted in improved courses and methods in the better high schools; for no subject is so perfect as to need no improvement; and any subject will soon be out of date if it lacks the elasticity which enables it to fit new conditions. There is still room for much improvement. Dr. D. E. Smith says, "I think unquestionably there has been too high a pace set in the matter of abstract drudgery. I think there is no question but that we must harmonize and vitalize our algebra." Other criticisms have been answered time and time again, but like Banquo's ghost they will not down. Prof. R. D. Carmichael, in *Science*, May 18, 1917, says, "It seems that no body of thought has been of more importance in human progress and at the same time been criticized more freely than the science of mathematics. Much of this criticism seems to be good natured and to amount to little more than a quasi-humorous way of expressing the critic's unashamed ignorance. At first sight one might treat this as harmless; but from the

point of view of general interest it can hardly be passed over in such a way. How this ignorance is to be overcome I cannot say. Perhaps one of the first requisites is to find some means of overcoming the shamelessness with which individuals otherwise well trained contemplate their own ignorance of mathematics." Prof. Chas. N. Moore, University of Cincinnati, in *The American Mathematical Monthly*, February, 1916, says, "The movement against mathematics is, for the most part, confined to a group of theorists who feel that they must advocate something new in order to convince their readers that they are investigators. This group, however, has made up in volume of sound what it has lacked in numbers. . . . The statement that there is at the present time much uncertainty as to the educational value of algebra and geometry will not bear examination." Dr. D. E. Smith, in *T. C. Record*, May, 1917, says, "It is by no means the advanced educator who denies a disciplinary value to geometry; it is rather, I think, either the educator who is slipping behind in the race, or the one who has never been in the race at all. If you do not think so, ask a man like Professor Thorndike. If anyone says to me that we have statistics to show that young people spend a year on a subject whose chief purpose is the logical proving of statements and are not thereby made more logical in their other lines of mental activity, now or in years to come, then I tell him frankly that not only do I not believe it but that scientific men generally do not." Our critics seem to be so fascinated by the weight and worth of their own ideas that no reply can reach them. Some seek to surprise us with the resurrection of issues that have been dead for ages. Others, in the face of irrefutable argument, do the seemingly impossible; they absolutely ignore the other side of the issue; they continue their argument as though it were impossible for them to be mistaken or for anyone to make a reply worthy of notice. Prof. Paul Shorey, in "The Assault on Humanism" (*The Alantic Monthly*, June, 1917), says, "They either have not read the literature which they controvert, or they intentionally ignore it. They do not inform their readers of its existence, and they do not even tacitly amend their own arguments to meet its specific contentions. In controversy, this is what Lincoln called 'bushwhacking.' In the authors of the textbooks of the science or the history of education it is the abandonment of the scientific for the frankly partisan attitude. . . . They not only argue as partisans against the classics but they systematical-

ly suppress both the arguments and the bibliography of the case for the classics. . . . The principal effort of the classicist who aims at argument rather than eloquence must be to shame his opponents from their unfair tactics, their neglect of the evidence, their preposterous logic, and to urge the educated public to examine the matter for themselves. He must wearily repeat his old list of 'must nots' and 'don'ts.'" These statements apply with equal force to many of the critics of mathematics.

As teachers of mathematics, we are too often the victims of men officially higher up, who know little of mathematics or of its teaching, and whom we allow to do our talking and planning for us. Why should courses and curricula in mathematics be arranged and criticized by principals and superintendents who have no appreciation of the subject? It seems to be different in Europe. Prof. J. C. Brown, in a recent bulletin of the U. S. Bureau of Education, says, "European school men believe that a course in mathematics should be planned by those who know mathematics rather than by educators who are practically ignorant of the subject." Educators not familiar with mathematics may aid in an advisory way; but, if the subject does what we claim for the student, it must have done that in some measure for the teacher; who then can be so well fitted to mould the subject into better form or to adjust its courses?

Some of the difficulties, and lack in interest of students in the study of algebra and geometry, are the result of preconceived notions, the echoes of what educational theorists have said. We have heard a teacher say that it is a pity that the active productive minds of young people should be burdened with so formal a study as algebra. A student who is looking for an easy time and who finds algebra hard work thinks he has sufficient authority in such a statement for loafing on the subject. This point is cleverly made by Prof. Crathorne in a parable given in "Algebra from the Utilitarian Standpoint" (SCHOOL SCIENCE AND MATHEMATICS, vol. 16, pp. 418-431). After considerable discussion on the part of Dr. Highbrow, Dr. Practical Man, Dr. Brown, and an Average Parent regarding difficulties in algebra and dislike for the subject, which the Average High School Pupil seemed to be experiencing, the pupil broke in with, "But I don't dislike algebra. I never did; but so many people argued that I disliked it that I began to think there was something wrong with it." That much of the lack of interest on the part of students towards mathematics is merely assumed is shown

in a report by this club published in SCHOOL SCIENCE AND MATHEMATICS, October, 1916. A test was given in three high schools—University High and Hyde Park, Chicago, and Oak Park, Ill.—to determine from the statements of students in these schools the measure of enjoyment they found in their various studies. Out of a total of 2,018 pupils reported as taking mathematics, 1,769, or 87.7 per cent, said they got some enjoyment from the study; 991, or 49.1 per cent, claimed to get very much enjoyment; and only 229, or 12.3 per cent, said they got no enjoyment. With one year of mathematics (at least) required of all students in these schools, and in view of present criticisms, these results are remarkable. Subjects which ranked higher were purely elective. It is the opinion of Prof. J. W. Johnson that 49 per cent of the pupils who study mathematics, including the high schools of the entire country, would vote that they got very much enjoyment from the study of mathematics.

It would be a mistake to try to persuade ourselves that no criticisms are worth our attention. The destructive critic always defeats his own ends, and is unworthy of serious consideration; but the constructive critic is always welcome; providing he maintains a friendly spirit. We must have the assistance of the latter. G. St. L. Carson, in "Mathematical Education," pp. 61 and 85, says, "The whole world is going through a transformation, due in part to scientific and mechanical invention and in part to the growth of separate nations, each with its own methods and ideals, of which no man can see the outcome. Our function, the function of all teachers, is to produce men and women competent to appreciate these changes and to take their part in guiding them so far as may be possible. Mathematical thought is one fundamental equipment for this purpose, but mathematical teaching has not hitherto been devoted to it because the need has but recently arisen. But now that it has arisen and is appreciated, we must meet it or sink, and sink deservedly. Neither the arid formalism of older days nor the workshop reckoning introduced of late will save us. The only hope lies in grasping that inner spirit of mathematics which has in recent years simplified and coordinated the whole structure of mathematical thought, and in relating this spirit to the complex entities and laws of modern civilization. . . . Salvation from our present difficulties can come only from the efforts and experiments of teachers themselves. Educational matters are in a ferment. Men are asking more and more insistently

why this and that are done, and they are right in their insistence. Unless fitting answers are ready, our work will stand condemned; the degradation of our subject to the domain of purely immediate utility will surely follow, as also the loss of that higher mental training which is so essential to the formation of an efficient citizen." To meet this situation we would make the following suggestion:

Mathematics should be *required* of every secondary school pupil. This required work may consist of courses alloted to the junior high school, if that institution is to prevail; or it may, under the present arrangement, be reduced to one year and consist of algebra and geometry, with some reference to the use of the trigonometric functions. The purpose being, in any case, to give to all, early in their course, some command of mathematics as a tool; to give some knowledge of its historical development; to instill an appreciation of the importance, possibilities, and beauties of the subject; and, above all, to give the pupil a chance to find himself. Those who have little aptitude for mathematics would not elect additional courses, and yet would realize some of the benefits from its study. This would probably reduce pupil mortality in our h'gh schools and remove much of the grounds for present criticism. On the other hand, such an arrangement wou'd throw responsibility on the teacher to interest his pupils in mathematics while taking the required courses so that they would elect other courses in the subject. This might aid in securing better teaching and better teachers. This club has already expressed its approval of reducing the required mathematics in high school to one year. Prof. Paul H. Hanus, of Harvard, in his book, "A Modern School," pp. 76 and 83, says, "Permanent lack of interest in a given field of work is an indication of corresponding incapacity; for growing interest and capacity always go together. . . . No pupil should be required to pursue a study after it is clear that it does not appeal to him. Under most circumstances one year is enough—and it is not too much—to ascertain whether a study does, or does not, challenge a youth's interest and capacity. . . . One year of elementary algebra and geometry may open the pupil's mind to one of the most useful, the most profound, and to some minds most fascinating systems of thought which man has developed—a result which can never be expected to follow from what the pupil has learned in the narrow field covered by arithmetic." Regarding the nature of elementary courses in mathe-

matics, Prof. G. A. Miller, in the preface to his "Historical Introduction to Mathematics" (1916), says, "Early mathematical courses should be more informational, especially along historical lines, on the ground that knowledge begets interest in knowledge." That a well-planned and interesting course should be required there can be no question. No one can know whether or not he has aptitude for the subject until he knows something about it. One cannot know anything about mathematics, to such an end, until one has studied the subject.

The Lincoln School, established this fall as a part of Teachers College, is an effort to determine the value of some of the modern theories of education, and to work out a better program of study than we have at present. We shall await with interest and shall welcome the results of this effort. It announces that it will attempt "in the subject of mathematics to develop a course which connects the study of mathematics with its use, adequate provision being made for those whose special abilities or future interests relate to mathematics. And in all subjects, whenever feasible, effort will be made to base schoolwork upon real situations, to the end that schoolwork may not only seem real to the pupil, but be so." It would seem that our work in algebra and geometry might be more completely related to the interests and activities of the pupil than at present. It would seem that this result might be accomplished by a greater number and variety of practical problems, even though these had little direct relation to the utility of the subject in later life. To say that only those problems which are directly related to the doing of the world's work are legitimate is to place mathematics on a utilitarian basis, and this we have shown to be wrong. The values we have suggested can be realized when the pupil is thoroughly interested in his work regardless of its actual use in later life. However, as often as possible problems should be useful as well as interesting. Considerable progress is being made in this line in various parts of the country.

Surely all important departures from the established order of things should be made slowly, and only after these have been carefully tested. Experiments with high school mathematics should be made in schools adapted to that use, and by those who are expert in mathematics as well as in the teaching of the subject. This, of course, would not preclude the possibility of important discoveries and contributions by any teacher situated in any school.

The high school is *not* the place to specialize. The required courses in mathematics must be adapted at the same time to the pupil who does not and to the one who does go to college. Diversified courses may have a place as electives and in vocational and technical schools. Only a very small number of high school pupils can have any adequate notion of what their life's work should be. It is a great mistake to force—or even to permit—them to follow courses that may exclude them from the vocation for which they are best fitted. President Hadley, of Yale, says that only about 8 per cent of pupils previous to seventeen years indicate inclinations towards any vocation. Dr. Joseph Rausohoff, an eminent surgeon of Cincinnati says, (*School and Society*, June 19, 1915) "Up to the fifteenth or sixteenth year the average boy who goes to a high school can have no idea as to the work he expects to follow in later life. A general course will give the boy a general knowledge which will later permit him to develop along certain lines, as his bent or necessity may indicate. Such a course makes the possibility, at least, of a general culture which will permit him to indulge in one or another intellectual hobby later in life. I would above all things not exclude mathematics, but make it compulsory in every high school curriculum, because it is, after all, the only study which will inculcate into the young mind that absolute precision is among the human possibilities." Opportunity for the broadest possible education must be given to everyone. This is an essential thing in a democracy where equal opportunity should be enjoyed by all. We cannot say to one pupil, "The door to the highest attainments in education is open to you"; and even suggest to another, by limiting his field, that the same door is practically closed to him. This should be our ideal in curriculum making and in teaching, and it should be kept constantly before both teacher and student. The way to the highest achievement must not be closed to anyone.

We have quoted freely in defense of our arguments, for the words of a thinker carry their own weight. We are reminded of the words of Emerson, in "Letters and Social Aims, Quotation and Originality": "A great man quotes bravely, and will not draw on his invention when his memory serves him with a word as good." The value of a well-expressed thought or of a good piece of work depends on the use made of it—the passing of it along. We have quoted from specialists in mathematics, for who but those who know and appreciate a subject can speak

with authority about it. Lest this should seem a biased attitude, we have also quoted specialists in other lines, and have even given the opinion of students in high school. Some may object that mathematics has changed since some of these statements were made concerning it, and that they are therefore of doubtful value. While mathematics is not today what it was yesterday, it is not less but more important.

That mathematics is advancing today as never before is shown by the following quotations:

G. A. Miller, "Historical Introduction to Mathematical Literature," p. 22, "It would be very conservative to state that the first decade and a half of the present century (twentieth) produced at least one-fifth as much (mathematical literature) as all the preceding centuries combined. Hence it appears likely that the twentieth will produce, as the nineteenth century has done, much more new mathematical literature than the total existing mathematical literature at the beginning."

C. J. Keyser, in a lecture ten years ago, "2,000 books and memoirs drop from the mathematical press of the world in a single year, the estimated number amounting to 50,000 in the last generation. . . .

"Indeed, the modern developments of mathematics constitutes not only one of the most impressive, but one of the most characteristic, phenomena of our age. It is a phenomenon, however, of which the boasted intelligence of 'universalized' daily press seems strangely unaware; and there is no other great human interest, whether of science or of art, regarding which the mind of the educated public is permitted to hold so many fallacious opinions and inferior estimates. The golden age of mathematics—that was not the age of Euclid, it is ours."

President N. M. Butler, of Columbia University, "Modern mathematics, that most astonishing of intellectual creation, has projected the mind's eye through infinite time and the mind's hand into boundless space."

Jas. Pierpont, "Surely this is the golden age of mathematics."

ALFRED DAVIS,
Chairman,
William and Mary College,
Williamsburg, Va.
J. A. FOBERG,
Crane Technical High School,
Chicago, Ill.
A M. ALLISON,
Lakeview High School,
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M. J. NEWELL,
Evanston High School,
Evanston, Ill.
C. M. AUSTIN,
Oak Park High School,
Oak Park, Ill.
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A PRACTICAL VALENCE EXPERIMENT.

By PAUL H. FALL,

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Doubtless many teachers of chemistry use, as a class demonstration, Dr. W. A. Noyes' famous valence experiment as given in his "Textbook of Chemistry." Perhaps it is not given in manuals as a laboratory experiment for the student to perform because of the difficulty of handling the sodium. It occurred to the writer to weigh the sodium in a small gelatin capsule. This method may not be new but the writer has seen no mention of it in any journal or manual.

The experiment as carried out in our laboratory is as follows: Lengths of clean (made so by rubbing with emery paper) magnesium ribbon and aluminum wire are cut which will give approximately milligram-atomic weights of the metals. (This is easily determined by weighing 10 cm. of the ribbon or wire and then by proportion finding what length is required to give 24.3 mg. of magnesium or 27 mg. of aluminum.) Each student takes a small envelope containing the empty capsule he has weighed to the stock room where the attendant puts in approximately a milligram-atomic weight (23 mg.) of sodium from a small sodium press, to be described later. The capsule of sodium should be weighed soon after filling; otherwise the surface of the sodium will oxidize. In most cases, however, the oxidation in one hour is negligible.

After all three of the metals have been weighed they are introduced under three inverted test tubes of about six normal hydrochloric acid. For the sodium, water alone is sufficient. The capsule of sodium rises to the bottom of the inverted test tube and in a few minutes enough of the capsule dissolves to allow the sodium and acid or water to react. (As an explosion sometimes occurs with sodium, it is best to throw a towel over the tube.) Any sodium retained by the capsule may be made to react with the water by shaking the test tube in a deep pneumatic tank of water. By means of rubber bands the height of water or acid left in each tube is marked, and then the volume of hydrogen generated in each case is measured.

In each case, from the volume of hydrogen obtained (when reduced to standard conditions) and the weight of the metal used, the student computes what volume of hydrogen he would have obtained had he used exactly a milligram-atomic weight of the metal. Then the actual weight of this hydrogen is de-

termined and the ratios in which it is displaced by the metals is computed.

It will be found in exact work that 23 mg. of sodium will displace 11 cc. (1 mg.—which is the milligram-atomic weight) of hydrogen; 24.3 mg. of magnesium will displace 22 cc. (2 mg.) of hydrogen; and 27 mg. of aluminum will displace 33 cc. (3 mg.) of hydrogen. It should be remembered that just one milligram-atomic weight of the metal was used in each case. By using the atomic weight of each metal in milligrams, it is evident we should be using an equal number of atoms of each metal. Hence from the above results it is evident that:

1 atom (or atomic weight) of Na will displace 1 atom (or atomic weight) of H, and as a result will hold 1 atom (or atomic weight) of Cl.

1 atom (or atomic weight) of Mg will displace 2 atoms (or atomic weights) of H, and as a result will hold 2 atoms (or atomic weights) of Cl.

1 atom (or atomic weight) of Al will displace 3 atoms (or atomic weights) of H, and as a result will hold 3 atoms (or atomic weights) of Cl.

We see that the displacing capacity (towards H) and the holding capacity (towards Cl) is twice as great with Mg as with Na and three times as great with Al. We call this capacity *valence* and define as univalent, any element one atom of which displaces one atom of hydrogen or holds one atom of chlorine; as bivalent, any element one atom of which displaces two atoms of hydrogen or holds two atoms of chlorine; and as trivalent, any element one atom of which displaces three atoms of hydrogen or holds three atoms of chlorine.

During the past two years this experiment has been performed by more than 350 students in our laboratory in the beginning course and with very good quantitative results and, best of all, it has proved a great aid to the understanding of valence by the student. In the Analytical Department students have been using the gelatin capsule for weighing out sodium and calcium in determining their equivalent weights and the results have been very satisfactory. It is evident that the data obtained from the experiment outlined above may also be used for the determination of the equivalent weight of each of the metals that was used.

In place of the usual expensive sodium press we used a very efficient substitute, made in our laboratory by Mr. E. H. Park.

It was made as follows: A piece of 3-8 inch gas pipe 2 inches long was reamed out with a 15-32 inch drill. On one end a pipe-cap was screwed. A steel plunger 2 1-2 inches long and 29-64 inches in diameter exactly fitted into the above cylinder. A 1-8 inch hole was drilled through the side of the capped end of the cylinder so it just cleared the inside end of the cap. The clean, dry cylinder was filled with bright sodium and the plunger forced in with a vise or by driving it in with a hammer, the closed end being placed on a block of iron. The sodium was forced through the small hole in wire-like form.

PEDAGOGICAL FALLACIES IN TEACHING PHYSICS.

By J. GARRETT KEMP,

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The pedagogical fallacies practiced by some teachers of physics, and often found in apparently well written textbooks of physics, are exceedingly unworthy of any attempt to offer apologies.

Students at the mercy of such teachers and textbooks do not know why the subject is so difficult for them to grasp when the learning process is interrupted by the unlearning process. In other words, part of the students' efforts are employed in learning some physical terms and their associated concepts correctly, and part of their efforts worse than wasted in unlearning what has been obtained incorrectly, if despair has not entirely gained complete possession. I shall endeavor to point out some of the fallacies just to show that they exist and merely suggest the consequences.

Mass and weight, for instance, are used indiscriminately, no matter whether the teacher or textbook means the quantity of matter or the force of attraction exerted by the earth upon a body. Sometimes this is due to ordinary ignorance, and at other times to carelessness or mental laziness.

Why should one say merely grams instead of grams mass or grams weight—the former meaning quantity of matter and the latter a force? No one would be satisfied to take a check in payment of an account which is signed with only the given name of the payer. The result of this sort of pedagogical fallacies is found in the following: Density is correctly defined as the quantity of matter in a unit volume or the mass per unit volume of a substance. It is true that the weight of a body divided by its volume will give a number which is approxi-

mately the same as that for the density of the body. Why should the density of a body be defined as its weight per unit volume, which means a force divided by a volume, when it is desired to convey the idea of the quantity of matter in a unit volume of a body? There is made no clear definite distinction between specific gravity and density in some textbooks. Density in grams mass per cubic centimeter has the same number as specific gravity merely because the mass of a cubic centimeter of water at standard conditions is taken as unity. Specific gravity is often incompletely defined as the relative density of a substance when it should be defined as the relative density of a substance as compared with the density of a standard substance; however, even this latter definition, while complete, is insufficiently definite to give a clear concise meaning. The specific gravity of a substance should be defined as the ratio of the density of the substance to the density of a standard substance. This definition indicates that the density of a substance may be found by multiplying the specific gravity by the density of the standard substance.

The following questionable definitions for specific gravity are often found in textbooks: "The ratio of the weight of the substance to the weight of an equal volume of water; and the weight in air divided by the loss in weight when immersed in water." These definitions are correct only in so far as they give the numerical value of specific gravity of a substance; however, they do not give sufficient information in themselves to determine the density of a substance when the specific gravity and the density of the standard substance are known. The student is even more at sea when water is not used as the standard since at times it is more convenient to use a gas, such as hydrogen.

Some textbooks present the subject of specific gravity in connection with Archimedes' principle in such a manner that the real significance of the principle is buried in wrong notions of specific gravity, and, moreover, the undue emphasis given to this presentation by the relatively large amount of space in the text creates erroneous ideas concerning its importance. The general impressions resulting from this study prevent the student from understanding the real significance of Archimedes' principle, because of the failure to properly emphasize the fact that it is merely used to determine the volume of regular or irregular shaped bodies readily. This principle is used to

determine the density of a body in grams per cubic centimeter; however, if the British system of units were used, the student would soon understand that it is not the same as the specific gravity and is not equal to the ratio of the weight of the body in air to its loss of weight in water when totally immersed. In the metric system of units the loss of weight in water of an immersed body, or its buoyant force, has approximately the same number of grams weight as cubic centimeters of volume of displaced water, since the density of water is taken as unity, but when the British system of units is used, the buoyant force must be divided by the density of water, 62.4 pounds mass per cubic foot. How can we expect a student to find his way out of this mental maze?

The word gravity as used in physics is only a part of the phrase "force of gravity" and when it is used alone should convey the idea of a force. The acceleration due to the force of gravity is often called "gravity," nevertheless acceleration is the time rate of change of velocity which is caused by a force. The true physical meaning of acceleration is one of the most difficult of physical concepts for students to grasp, yet the stumbling block just mentioned is deliberately thrown in the way.

The law of conservation of energy is put into such glib language that very little mental effort is required to grasp its true significance, if the student is capable of thinking in terms of the universe and of indestructibility. Energy is indestructible, the total amount of energy in the universe is never changed, are several of those most used without any concrete application. When the study of simple machines is reached, instead of applying the law of conservation of energy to those assumed ideal machines the "work principle" or "input equals output" is used with no reference to the fact that the principle is merely a restatement of the conservation law. Practically less than ten per cent of the textbooks on elementary physics mention anything about the availability and unavailability of energy. That energy is indestructible is as near meaningless to the student as anything can be, is self-evident to any real teacher of physics; however, the truly practical idea of unavailability of energy, which demands much intense activity of the mind and fills up a vital discontinuity in the learning process, is almost utterly neglected. It seems that mere skeletons of words without living purpose are being taught in place of those essential physical concepts that make the physical world a place of in-

tense interest and beauty because of genuine knowledge concerning it. The student must needs wonder at the much ado about the law of conservation of energy and the heralded importance of it when there is such little earthly application to show him the truth of these assertions. The student must of necessity think that the law is some celestial idea applicable only to that which is perfect by those who are perfect. I should like to see elementary textbooks bring this great and useful law to earth where we live and learn.

The term pressure seems to be used in various ways to mislead the student. It is defined as the force acting upon a unit area, yet some well written textbooks use the term pressure to convey the idea of a force that presses bodies together, or as a force which produces compression, and, quite often, as the force produced by pressure. Sometimes statements made in textbooks concerning friction refer to the force normal to the plane of motion as the pressure, and, in dealing with the hydrostatic force exerted upon the bottom or sides of a vessel due to the contained liquid, it is called total pressure. There is one and only one meaning which should be conveyed by the term pressure and that is the force per unit area. How can a student tell what is meant when the same term is used to express different ideas?

The term power is correctly defined as the time rate of doing work, or the time rate of expending energy. It is used, however, to convey very indefinite ideas such as capacity to do, capability, and even a force in addition to its true meaning.

If the fundamental purpose of such textbooks were to prevent or at least hinder the learning process rather than to foster and nurture it, one could easily compliment the authors and envy them too in their success. The question: "Why is physics so difficult?" is easily answered without blaming mathematics.

I shall pass over many other instances of this form of sophistry too numerous to even mention lest I tire you with too lengthy and monotonous discussion.

In closing, let it suffice to merely mention the fact that "If there were no ears to hear there would be no sound," and "If there were no eyes to see there would be no light," are expressions worthy of their place in the study of psychology; however, in physics we find it necessary to construct ears to hear sounds and eyes to see light to which our natural organs are insensible.

Let this discussion suffice for high school and elementary college physics and let me merely mention the fact that much may be said concerning advanced physics as taught in our colleges and in our universities.

Physics seems to lead all other exact sciences in tolerating pedagogical fallacies and in suffering untold deliberate neglect on account of the forms of sophistry practiced. If those who teach physics consider it an exact science, why not endeavor to be exact in the teaching process?

"O consistency, thou art a jewel."

PETRI DISH PROJECTS IN BIOLOGY.

By G. B. CLAYCOMB,

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One phase of the biology work in the Missoula County High School has been so successful and helpful to the pupils that its discussion here seems justifiable.

In connection with the study of bacteria, each member of the class chose a problem interesting to himself which he could work out with culture medium in Petri dishes. The nutrient agar-agar medium was prepared during the regular laboratory period by two of the boys according to the following general formula:

Water	1 liter
Liebig's extract of beef	10 grams
Common salt	10 grams
Peptone	10 grams
Agar-agar	10 grams

The beef extract was dissolved in the liter of water. The agar was cut into small pieces, and along with the salt and peptone, added to the solution. The mixture with the pan was then weighed and heated until the agar was completely dissolved. Water was then added until the original weight was restored. Enough sodium hydroxide solution was introduced to make the medium slightly alkaline, as indicated by litmus paper. The solution was filtered while hot in the steam of a sterilizer. The flasks containing the medium were plugged with absorbent cotton and thoroughly sterilized.

About twenty cubic centimeters of the hot medium was transferred by means of a pipette to each of the sterilized Petri dishes. The dishes and their contents were sterilized in steam for about thirty minutes on three successive days. This last treatment was thoroughly done to prevent the development of colonies from spores. The dishes were then ready for use.

After use, the dishes were put in a warm, dark place.

The projects were mostly of the pupils' own selection. The following list will give a good idea of the nature of the subjects chosen:

The relative number of bacteria in pasteurized and unpasteurized milk.

A comparative study of bacteria in Missoula river water and tap water.

Bacteria on the fingers before and after washing.

Effect of heat on the growth of bacteria.

How does light affect the growth of bacteria?

The effect of low temperature on the growth of bacteria.

Bacteria in the air of a room after sweeping with a broom and with a vacuum cleaner.

The value of the use of sweeping compound in reducing the number of bacteria in school room air.

The effectiveness of common disinfectants and antiseptics.

The value of salt, sugar, and vinegar as preservatives.

The value of keeping the teeth clean. Bacteria on the teeth.

Should animals be kept in the house? Bacteria on dog and cat hair.

Should snow be eaten? Bacteria in snow.

Bacteria on a soiled handkerchief.

Should girls put their hair in their mouths? Bacteria on human hair.

Bacteria on coins and paper money, pencils and erasers.

All these and other projects were worked successfully by the members of the class.

Other problems will suggest themselves to anyone taking up this kind of work. Some that come to mind are as follows:

Are bacteria thrown out by a person having a cold, in coughing and sneezing?

Do tooth brushes need to be sterilized occasionally?

Should clothes be brushed in the house?

Does boiling water kill the germs in it?

Do flies carry bacteria on their feet?

Does freezing kill bacteria?

The following descriptions of the experiments performed, taken from the students' notebooks, will give a good idea of the reaction to the work:

PROBLEM.

To determine the relative number of bacteria in the air of a room during dry sweeping and vacuum cleaning.

METHODS AND OBSERVATIONS.

I exposed a Petri dish containing an agar medium for five minutes in a room during the process of dry sweeping. Several days later I exposed another Petri dish for five minutes in the same room while the vacuum cleaner was being used. The dishes were placed in a warm dark place. About five days after exposure colonies of bacteria appeared in the dishes. I observed that a great many more colonies of bacteria developed in the Petri dish which had been exposed in the room swept with a broom than in the room swept with the vacuum cleaner.

CONCLUSIONS.

I have concluded that the vacuum cleaner should be used whenever possible. It should come into common use and if possible should exterminate the use of the broom.

PROBLEM.

Are bacteria present on cat hair?

METHODS AND OBSERVATIONS.

Several hairs were carefully taken from a pet cat and placed in a Petri dish containing agar culture medium. The dish was placed in a warm dark place and allowed to remain there several days before examination. After several days the Petri dish was examined and found to contain many colonies of bacteria. Some of these colonies were white, some were yellow, some were black and some were orange.

CONCLUSIONS.

I conclude that cats carry a great many bacteria and, unless bathed very often, should not be kept as pets in the house.

PROBLEM.

To determine whether bacteria are present on such common things as coins, and the points and erasers of pencils.

METHODS AND OBSERVATIONS.

A coin was touched in a Petri dish containing agar culture medium. The same took place with the point and eraser of a pencil. The dish was then placed in a dark, warm place. After four or five days I observed that the colonies of bacteria began to appear. The next time I observed that the bacteria had taken a certain shape, that being round and irregular, and that they had certain colors, those being yellow, white, and orange.

CONCLUSIONS.

I conclude that coins, points or erasers of pencils should not be put in a person's mouth. This is not only a bad habit, but the bacteria may also be harmful.

PROBLEM.

Does washing reduce the number of bacteria on the hands?

METHODS AND OBSERVATIONS.

After coming down stairs with my hand on the banister, I touched my finger in three places on the agar-agar in a Petri dish. I then washed my hands well with soap and touched another finger to the agar-agar in another dish. The dishes were then put in a warm dark place. When I examined the dishes after a few days I found many colonies of bacteria where I touched my finger before washing, but none where I touched my finger after washing.

CONCLUSIONS.

I conclude that washing frees the hands of bacteria, and that the hands should be washed often, especially before meals.

Each pupil was required to exhibit the results of his experiment, and describe and discuss his project before the other members of the class. This brought each problem to the per-

sonal attention of the class and enabled them to receive some benefit from the work of the others. Some of the boys manifested their interest by taking photographs of their Petri dishes after the colonies had developed. All the pupils seemed to feel that this kind of work was something worth while.

THE GRAPH OF THE UNIT PARABOLA.

By J. R. Sage, Jr.,
Iowa State College.

In teaching, we frequently use the unit parabola

$$y = x^2+bx+c \qquad (1)$$

where b and c are any integers, to illustrate various points in graphical solution and theory of equations, and we wish to be able to write without hesitation the equation of a parabola of the above form which will exhibit the properties under discussion. For instance, we may wish to illustrate the fact that the roots of an equation of the type $y = f(x)$ are the abscissas of the points where the graph of $f(x)$ intersects the x-axis. After writing our equation it is also of advantage to be able to sketch its graph quickly.

Now (1) may be written in the form

$$y = (x+b/2)^2+c-\frac{b^2}{4} \qquad (2)$$

showing that y is a minimum for $x = -b/2$ since $(x+b/2)^2$ is either zero or positive. Also, if $c = b^2/4 = (b/2)^2$, the right hand member of (2) is a perfect square and (1) has a double root, $-b/2$.

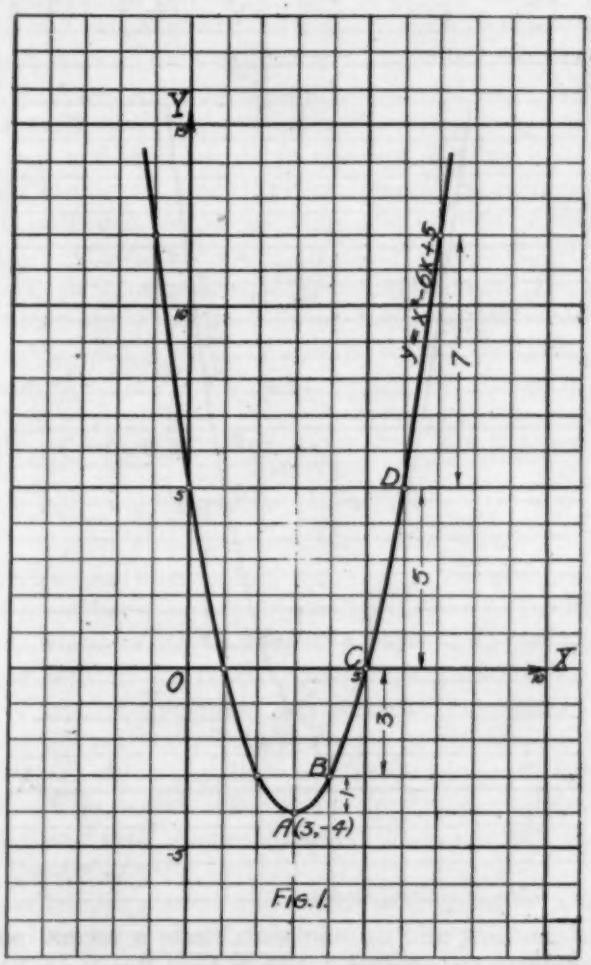
Graphically, this means that if c is chosen equal to $(b/2)^2$, the x-axis will be a horizontal tangent to the parabola at its vertex $(-b/2, 0)$. Then in order to have the vertex of the parabola fall below the x-axis, so that the graph will intersect the axis in two points, it is only necessary to choose a value for c less than that which would complete the square whose first two terms are x^2+bx. If c is k units greater or less than $(b/2)^2$, the vertex will be at $(-b/2, k)$ or $(-b/2, -k)$ respectively. If b is even, $(b/2)^2$ is integral and the coordinates of the vertex are integral. If b is odd, $(b/2)^2$ is not integral, the abscissa of the vertex is midway between two successive integers, and the ordinate of the vertex is one fourth unit less than some integer (K integral.)

Suppose it is desired to write the equation, having two distinct real roots, of a parabola of the above form, the abscissa

of whose vertex is 3. The first two terms of the function must be x^2-6x, the completed square of which is x^2-6x+9, a function whose graph would just touch the x-axis at the point (3, 0). But if c be changed from 9 to 5 the value of y for every value of x is decreased by four units and the vertex falls at (3, -4). Fig. 1 shows the graph of

$$y = x^2-6x+5 \qquad (3)$$

with vertex as stated above.



Now if a table of values of y in the general unit parabola be computed using equal x intervals, it will be found that the second differences of the y values will be constant and con-

sequently the first differences will be in arithmetical progression. If the x intervals are one unit, the second differences are two. This fact can be used in quickly determining sufficient points to sketch the graph.

Two cases arise, depending upon whether b is even or odd.

Case 1, b even. If b is even, we may begin at the vertex, A, Fig. 1 (which is easily determined as shown above), and going to

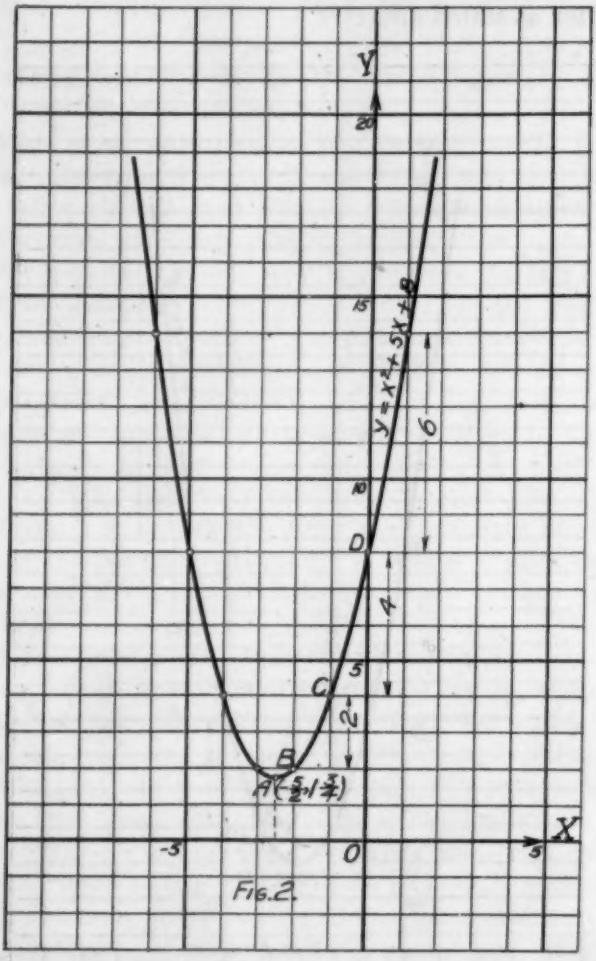


Fig. 2.

the right one unit and up one unit locate a second point, B, whose coordinates are integral. Then from B going to the right one unit and up three units we locate C, a third point on our graph. From C we go to the right one unit and up five units and so on, beginning at the vertex and going from point to point,

in each case increasing x by unity, the increments of y being the series of odd numbers, 1, 3, 5, 7, 9, ... In this way we may determine as many points as desired and sketch the parabola, also making use of the fact that the curve is symmetrical with respect to the line $x = -b/2$.

Case 2, b odd. We now use the graph of $y = x^2+5x+8$ to illustrate this case. (See Fig. 2.) The ordinate of the vertex is $c-(b/2)^2 = 8-25/4 = 1\frac{3}{4}$. Therefore, the vertex is at $(-5/2, 1\frac{3}{4})$.

Since the shape of the unit parabola is independent of b, we might start at the vertex as in Case 1, and locate successive points, but no point so determined would have integral coordinates. If, however, we start at the vertex and go to the right half a unit and then up one fourth of a unit, we locate a point B, Fig. 2, on our locus having integral coordinates. Then going from B one unit to the right and up two units we determine C. From C increase x by unity and y by four units to locate D, the increments of x, beginning with the point B, being unity and those of y being the series of even numbers 2, 4, 6, 8, ... , all points so located having integral coordinates.

AN OUT-OF-DOOR SCIENCE CLUB FOR HIGH SCHOOL STUDENTS.[1]

By LEON D. PEASLEE,

Public Museum, Milwaukee, Wis.

It is a generally recognized fact that the more interest in his subject a teacher can instil in pupils, the better the results obtained. Moreover, there is usually a desire on the part of the pupil, as well as the teacher, to go more deeply into certain topics of interest than time will permit in the classroom. For this reason, various organizations such as science clubs, history clubs, English clubs, etc., have been formed in most high schools. As science club work is the object of this paper, clubs other than those dealing with science proper will be omitted in the following discussion.

The writer has made a close study of high school and college science clubs for a considerable number of years and while he is firmly convinced that they are not only valuable but absolutely necessary for the proper teaching of science, still he feels that the difficulties under which most of these clubs operate

[1]Read before the Wisconsin Teachers' Association, November 2, 1916.

do not permit of that one phase of natural science work which is, perhaps, the most important of all, the study of nature in the great out-of-doors.

The membership of many clubs is made up of students from all the various science classes. Hence the average program must, of necessity, be of particular interest to certain groups of students rather than to the club as a whole. Moreover, meetings are almost invariably held after school hours; a time which is not overly conducive to student interest. There are, also, so many other things going on at this time, such as football, baseball and track team practice, recitals, business meetings, etc., that many members of a club that meets after school are bound to be absent. This is also responsible for causing many a good student to refrain from joining.

Because of the varying interests of its membership, the usual time of holding meetings and other reasons which need not be mentioned here, we see, then, that the average high school science club does not make it possible for its members who are particularly interested in nature study to go deeply into subjects of especial interest or make much, if any, out-of-door study.

With this point of view for guidance, the Educational Department of the Public Museum of Milwaukee organized in 1912 a science club for high school students which it hoped would offer to those who became its members an opportunity to go more deeply into natural history topics than either their school courses of study or their high school science clubs permitted, and to get out into the open to study nature first hand.

The process of organization and the results obtained in this club are made the basis of this paper. Nothing is included or suggested that has not been tried out in this society, which is known as "The Milwaukee Science Club."

As we have seen, it is useless to undertake an out-of-door club for high school students unless a suitable time for the same can be found. It is evident that it will be impossible to get the students to make field trips after hours upon school days, and, as Sunday is out of the question, Saturday alone remains. This, too, seems uninviting. Students who have been to school all the week are not inclined to enter into anything which looks like more school upon Saturdays, and besides, many find it necessary to work upon this day. Moreover, most all athletic contests, debates, entertainments and other amusements come either upon Friday evening or Saturday and at either time it

would be a hindrance. In spite of all these objections, Saturday morning is about the only possible time for meetings, and as experience has proven it is quite satisfactory, we may set aside that difficulty and proceed to the problem of membership.

Such a club will, of course, appeal only to a certain type of students. It will attract as a rule only those who are particularly interested in the natural sciences, and of these only those who have the time to spare upon Saturdays and who can see that what they are to do is to be far separated from school work.

The question as to whether or not both boys and girls should be admitted to membership in the same club is one which will have to be worked out in the individual cases. It may be mentioned, however, that generally speaking it does not seem advisable. There is the possibility that the club will develop into a social organization instead of one mainly for the study of science, if both sexes are included. With those students who are entirely sincere in their desire for such work there is little danger of this happening, but there are many who would artfully deceive even themselves into believing they had an exceptional interest in science if, by so doing, there was to be obtained the privilege of taking weekly walks into the fields and woods with their friends. Then there must also be taken into consideration the fact that the young ladies are generally capable of less endurance than the young men, and in a club which spends most of its time outside, that while the one will seem to always be holding back, the other will invariably seem to be trying to overdo. It was this fact alone which resulted in the Milwaukee Science Club becoming one solely for boys. Long, all-day tramps, perhaps in the dead of winter, and even during severe snowstorms, did not appeal to the girls, and as it was not possible to arrange for two kinds of work to go on at the same time, they gradually dropped out.

It is best to offer no incentive to obtain members other than the direct benefits to be derived. It so often happens that teachers excuse from examinations or give extra credit for such work in order to obtain members, and while this may serve its purpose, it attracts many who are not the best type of members, and tends to put a mercenary aspect upon the work even in the minds of the best students. There should be absolutely no relation between the club and the school through which the members might expect credit in any form from their teachers. Neither should there be any attempt to offer amusements to attract

or hold them. Except in unusual cases, a sufficient membership may be obtained simply by the opportunity of congenial friendships and an easy way of getting valuable information by a process so far divorced from the classroom method that it becomes a pleasure and not a task.

The selection of the new members should be very carefully carried out. Names may be suggested by the teacher or the members may be encouraged to scout out the desirable ones for themselves. In either case "the office should seek the man" and the club ought always to reserve the right to invite others to become candidates for admission. No one should be hastily taken in. The prospective member may be required to attend a considerable number of meetings (at least four) before his name is voted upon. During this time the members may have an opportunity to determine whether or not they consider him truly interested in the work of the club and a young man of desirable character, and at the same time he can determine whether or not he sincerely wishes to join.

Although there is, of course, a desire to have as large a membership as possible, still it is advisable to limit the number in the club at any one time to approximately twenty-five. No absolute limit should be set, however, for in case this is done there is sure to turn up just when the full quota has been obtained some student who would make an exceptionally valuable member. With many more than the above mentioned number the club becomes unwieldy in the field, and the members cease to obtain the element of personal association with and instruction from the advisor.

There is another problem of membership which will appear as soon as the club becomes well established, and that is, that many of the students who join when they are taking science work will wish to continue as active members while they are in school. A slogan which should always be encouraged is "Once a member always a member." It takes more than one year for the club to have its greatest influence upon the students, so the organization should be perfected in such a manner that it will hold its members as long as they are in the school, and even after that they should always be welcome.

With a membership made up of students perhaps from all four classes, it is true that a certain number who might wish to join will be ruled out. Still, if the results to be obtained are to be as far reaching as possible, the number must of necessity be lim-

ited. As there is no relation between the club and class work, there is no obligation to take in any more members than are desired, and consequently only the cream of the science students need be selected. It will soon become an honor to be a member of such a select society and no difficulty should be experienced in obtaining just the members desired.

Once the club is well under way, it is best to definitely organize according to recognized customs. A constitution vesting the entire control of the organization in the hands of its members should be adopted and officers chosen. Officers are best elected for a term of one year and should not be eligible to reelection to the same office. A short formal meeting held before each week's program will add to the dignity of the club. This may be either at the place of assembling or at some convenient point in the field.

The club should have a definite object and this may well be stated in some expression which can be considered as a motto. The motto of the Milwaukee Science Club leaves no question as to the purpose of that organization. It reads: "Study and Preserve the Works of Nature, Not Destroy Them."

After the officers have been elected and installed, the advisor should insist upon being considered simply as one of the members and claim no privileges not enjoyed by any of the others. In his position as advisor the members will naturally come to him for information they may desire, and while he always gives this freely, he should not use this influence unduly to control matters purely of club nature. Once the management of the club comes too directly under the influence of the advisor, it falls to the plane of the school society which is controlled, and often presided over by teachers. Such a condition can be only detrimental.

The kind of work which is selected and the way in which it is conducted has much to do with the success to be obtained. There is no end of interesting subjects which may be chosen and all may be treated in a way that will not savor of the classroom in any manner. In all this work there should be no attempt to require the actual memorizing of anything. All that is to be learned may be gradually acquired by the process of repetition. The members must be led to feel an interest in all nature, and whenever they come across anything which is at all out of the ordinary, or which they have not seen for some time, they will develop the habit of taking pleasure in calling attention to it

themselves. If they can recall the name and facts concerning the thing in question, they should do so without prompting by the advisor. In case they cannot, they must be encouraged to ask, and to continue to ask as often as they come across the same thing, until it becomes well fixed in their minds. In this manner much can be learned without taxing the memory in the slightest. As new members come into the club it will be noted that the older ones unconsciously take upon themselves the answering of the greater part of the questions, and the work becomes almost automatic; questions being asked of the advisor only when the information cannot be given by some member. This method is unique and the students enjoy the responsibility thus placed upon them.

As for the nature of the actual work of the club there are many possibilities. As the name signifies, the greater part of the activities should be out of doors, but provision must be made for inclement weather and particularly for the winter months when it is not always possible to get out.

In the beginning, no definite program of field work ought to be undertaken. Trips to the parks, fields and woods, as the desires of the members shall dictate, may be taken, and every effort made to make them interesting to all. A congenial friendship among the members must be of first importance, and these "walks and talks" will greatly facilitate this. The advisor should accompany the boys on all these trips and should aim to gradually develop their interest in the various phases of natural history which they encounter.

At first the social side of the club will probably dominate, and the trips will seem chiefly for pleasure, but before long the trend of thought will gradually turn into the desired channels. In an amazingly short time, with the aid of the advisor, the members will become acquainted with the trees, shrubs, wild flowers, birds, common rocks, geological formations, etc. They will, moreover, develop a marked pride in this newly acquired information, and will exert themselves in seeking out new facts, as well as handing down those already obtained to the new members who are just beginning the work.

All-day hikes taken from time to time also tend to hold the interest of the members, and these may be taken in the winter as well as in the summer. One will be surprised to see with what enthusiasm such a group of nature lovers will start out upon a twenty mile walk in the midst of a blinding snowstorm, and yet

he can readily see that the winter woodcraft which the boys learn will repay them for the hardships they endure.

As the various places to which the club can go in the short space of a morning are limited, it will be well in due time to undertake a more comprehensive study of individual localities. Zoological, botanical and geological surveys can be made without much trouble after the club becomes fairly well acquainted with the natural surroundings of the vicinity. A simple plane-table may be made and used to obtain suitable maps; the streams, swamps, hills, valleys, bluffs, etc., may be recorded; the flowers, shrubs and trees listed and the locations where the more interesting of these can be found shown upon the maps; even microscopic surveys of the pond and brook life may be worked out and included. Such a series of maps as these and their accompanying short descriptions if put in booklet form would not only be a credit to their makers but also of greatest value to the public in general and to teachers in particular.

During the winter months various programs can be arranged which will hold the interest of the members. Some winter field trips ought to be taken but as a whole the rigors of a cold climate will greatly reduce the roll call if such trips are made the rule. As the club is naturally interested in anything which is founded upon scientific principles, much of one winter may be spent in making a study of the various manufacturing plants of the vicinity. The boys will readily see the value of such trips, as they not only supply much interesting information but also material for the basis of many an English theme.

Another interesting line of winter work may be made possible by reserving the microscopic analysis of the brook and pond water until that time. If the club can have access to a laboratory and microscopes, mason jars of water, mud and dead leaves could be collected from various localities before the cold weather sets in and placed upon the laboratory window-sills for future reference. Before long these will be found to be teeming with a great variety of plant and animal life, and throughout the coldest weather much interest can be aroused in finding, studying and recording these minute forms of life.

It may be well to encourage certain students to undertake definite problems. The thorn-apple, sparrows, wild sunflowers, or ants of the neighborhood may need attention, and material and notes gathered at favorable times may be worked up during

the winter. This work will, of course, require serious thought, and while the majority may not care to undertake it there should be some to whom it will appeal particularly.

If the advisor has the time and the inclination, one of the most interesting and at the same time most valuable of winter activities may be a series of talks given by him upon some topic which the club may select. There is an opportunity here to do a wonderful amount of good if these talks are properly conducted. Human anatomy, physiology, embryology and sex hygiene are but a few of the many subjects which will appeal to all young men. In the giving of these talks one can go far beyond the possibilities offered in the classroom and can thus supply a much needed want.

The advisability of discussing these, or any other subjects in fact, need not be raised, for the young men have already passed the age of morbid curiosity and have reached that of sincere desire for knowledge. They have reached a period when they should thoroughly understand the human body and its functions. They cannot get this in the meagre courses offered in our high schools, and their parents are seldom in a position to enlighten them. Who else, then, than one who has walked with them, talked with them and perhaps camped with them, could be better fitted for the imparting of this knowledge? Moreover, such an undertaking will not only meet with the hearty approval but even the urgent desires of most parents who will readily see the exceptional value of talks of this kind.

The spring and fall months, as we have seen, should be chiefly spent out of doors; the winter months are well suited for various indoor activities; lastly we must not forget the summer vacation. During this time it will not be advisable to attempt to hold regular weekly meetings and the activities should cease entirely except, perhaps, for occasional all-day hikes, unless a definite camping trip can be undertaken.

If such a trip is contemplated, the plans ought to be laid long before hand. For the best results a stay of fully three weeks should be arranged; and the site selected should be upon the forested shore of some lake or waterway as far as convenient from civilization.

Experience has shown that the expenses of an undertaking of this kind, when the distance does not exceed two hundred and fifty miles, and the stay three weeks, need not be over twenty-one dollars per member. This should cover carfare (without

sleepers, as the boys are going camping anyway), boat rental, three meals a day (and growing boys are good eaters, too), and all other accessories. To raise the money for a camping trip the boys should start saving early. A banking system can be worked out among the members themselves and small deposits made weekly. During a part of the summer many will doubtless obtain regular positions to make up the difference.

How close the boys can get back to nature and what a wonderful experience it will be for them can only be realized by one who has actually tried the experiment. The hardships of a long tedious hike with heavy packs, or the steady pull of the oars hour after hour; the pitching of the camp; the sleeping upon balsam beds; the controversy with mosquitoes, deerflies and other of nature's pests; the cooking of their own meals and the eating what they have cooked, mingled with the pleasures of fishing, bathing, hiking, exploring and the most congenial of comradeships, make camping a fitting climax for the activities of an out-of-door science club.

With facts such as these in mind, one cannot hesitate to agree that an out-of-door science club for high school students is both possible and desirable. The benefits are far reaching. Such activities are exceptionally educational and broadening. The walks through the fields and woods and the experiences of camp life truly open before the boys the doors of nature, disclosing a world of interesting things that will be a pleasure to them as long as they live.

In this practical age every business enterprise one understands, whether it be the making of soap, candy, brooms or automobiles, the reading of the weather or the conducting of a police court trial, is one more rung in the ladder of individual progress.

The human body is a most wonderful and intricate organism, yet how little we know about its vital functions. What study and care we give to the delicate mechanism of our gun or auto while we carelessly leave our bodies to care for themselves. A comprehensive study of the body and its functions cannot help but be of greatest good to maturing boys, and the vigor with which they attack such serious problems, the frankness with which they ask the many questions which they have hesitated even to suggest to their parents, and the readiness with which they assimilate the valuable lessons taught will, in themselves, amply repay for all his efforts, him who gives his valued time to such a club.

ACOUSTIC ATTRACTION AND REPULSION.

C. C. KIPLINGER,

Ames, Iowa.

Much of our knowledge of wave motion is based upon the study of acoustics. A sound wave is an easily demonstrable vibration of a well known elastic medium, air. Hence, in acoustic attraction and repulsion, the properties of both the vibrating medium and the vibration are well known.

Guyot, Guthrie and Shellbach observed independently that a sounding body in a state of vibration attracts or repels objects near it. It was concluded from experiments of this kind that "the vibrations of an elastic medium attract bodies which are specifically heavier than itself and repel those that are specifically lighter."

For example, if a strip of paper is suspended at one end and a vibrating tuning fork is brought near it, the paper moves toward the fork. Air is the vibrating medium and the vibrations are composed of alternate compressions and rarefactions. Guthrie found that the air about the prong of a vibrating tuning fork is expanded. Hence, the paper is attracted to the fork owing to the difference of pressure on its two faces; the lesser pressure being on the side nearest the fork. Therefore, we may conclude that vibrations in an elastic medium cause expansion of the medium and that attraction, in some instances at least, is a function of pressure differences.

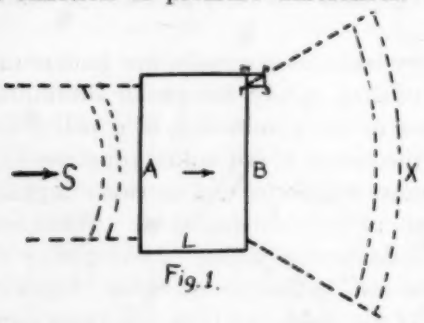


Fig. 1.

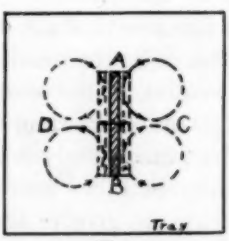


Fig. 3.

On the other hand, we read in "Ganot's Physics," Ed. 17, page 282, that a balloon of gold-beaters skin filled with hydrogen and tied down by a thread is repelled by a resonance box on which a tuning fork is vibrating. This may also be explained on the basis of pressure difference. In Figure 1, L is the hydrogen lens, with the walls A and B of thin membranous material. A sound wave, S, impinging on L is refracted outward, owing

to the relatively small density of hydrogen; L behaving like a conclave lens. The wave S exerts pressure on A. Since the wave is bent outward at B, the force due to the wave pressure may be resolved into two components, one parallel to B, and one perpendicular to it.

In other words, the force normal to the surface at B is less than at A, these unbalanced pressures resulting in movement toward X. Hence, we may have repulsion resulting from a difference in pressure. Therefore, it would seem to follow that a freely moving body in an elastic medium, different portions of which are, for some reason or other, at different densities, will always tend to move toward the region of least pressure.

This is true in the case of bodies floating on the surface of a liquid. Two bodies, both of which are, or are not, wet by the liquid, mutually attract each other, owing to the lessened pressure between them. If the liquid wets one and does not wet the other, the pressure between them is increased and repulsion results. Again we find attraction and repulsion to be functions of pressure differences.

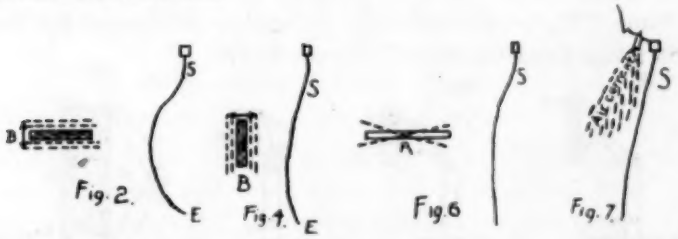


Fig. 2. Fig. 4. Fig. 6 Fig. 7

Procure a strip of paper about two inches wide and three feet long, also a small piece of board; the top of a cigar box will do nicely. Fasten the strip at one end to some convenient support, so that it hangs freely. Then take the board and cause it to move up and down as rapidly as possible near the paper, as shown in Figure 2. The paper will move toward the board. The air has been set in motion and pressure differences have been created, resulting in the attraction of the strip. The bending of the paper away from the board at E shows that an air current traveling in that direction is producing increased pressure and hence repelling the strip.

The production of currents by an object vibrating in a fluid may be shown as follows: Fill a rather large tray about two-thirds full of water and dust some lycopodium powder, or cork filings, over its surface. Procure a glass strip and hold it so that one edge is slightly below the surface of the water. Now move it rapidly to and fro through a short distance.

Observe the direction of the currents formed. They flow in at both ends of the strip and out at the center, Figure 3. Hence, we find that the strip of glass is attracting particles at A and B and repelling them at C and D, owing to the currents produced by vibrations. However, water is only slightly compressible. For this reason the phenomena of vibrations in air differ from those in the former fluid.

To illustrate. Cause the board of experiment one, Figure 2, to rapidly approach and recede from the paper band. The band approaches the board, as before, Figure 4. The curious thing here is that the rapid movement of the board toward the paper causes the latter to approach the former in turn.

What takes place as the board nears the strip? Let us illustrate by another experiment. Cause the board to rapidly approach the rather tall flame (luminous) of a Bunsen burner. The flame darts toward the board, Figure 5, A. Now cause the board to rapidly recede. The flame follows the board, Figure 5, B. Attraction results in each case. Now strike at the flame with the board, suddenly arresting its progress just as it almost touches the flame. For an instant only, the middle portion of the flame bends away from the board, Figure 5, D.

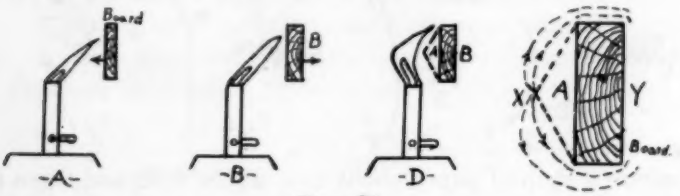


Fig. 5.

Figure 5, C, shows what has probably taken place. Upon moving B rapidly through the air in the direction shown, the air nearest the board piles up on its surface and is slightly compressed. Hence, it is this pyramid of relatively denser air that bends the flame outward at D, Figure 5. The air further away from the center of the board spills over its edges and produces a region of lessened pressure at X. The movement of the board away from Y produces lessened pressure in this region. The air flows from X, tending to restore normal pressure at Y. Thus the movement of the flame toward the board, whether the latter is receding or approaching, is due to pressure differences caused by this motion.

A vibrating tuning fork will attract a strip of paper in its

vicinity, not only if the face of a vibrating prong be brought near the paper, but also, although to a less marked degree, if the ends are approached to it. This may be illustrated by rapidly vibrating an ordinary foot rule between the thumb and fingers, and holding one end near a strip of paper, Figure 6. The paper is attracted as before. The air forced off the end of the rule toward S does not balance the decreased pressure due to the movement of R through the air.

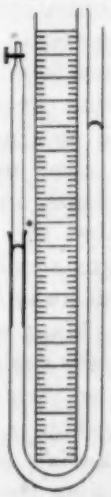
If, as in Figure 6, we take a tube and blow a current of air through it, the paper can be made to follow the current, upon changing the direction of the latter. Hence, these experiments to indicate that attraction and repulsion in the known elastic medium, air, are functions of differences of air pressure. Moreover, they suggest that a vibrating body in an elastic medium produce those differences of pressure which result in the phenomena of attraction and repulsion.

BOYLE'S LAW APPARATUS.

By RALPH C. HARTSOUGH,
High School, Wichita, Kansas.

DESCRIPTION OF APPARATUS.

The U tube is an unequal arm glass tube. The longer arm is about 18 inches and the shorter arm is 12 inches long. In the short arm is a short glass tube about 12 inches long. This short glass tube fits snugly into the short arm of the U tube by means of appropriate packing, and is fitted with a stop cock at one end.



USE OF APPARATUS.

Mercury is used in the U tube. The confined gas in the glass tube is compressed or expanded by pushing it as a piston into the short arm of the U tube.

ADVANTAGES.

1. Small amount of mercury required.
2. Ease of manipulation.
3. Compactness, simplicity and cheapness.
4. Accuracy of readings.

THE PRESENT STATUS OF HIGH SCHOOL SCIENCE.

By WILSON C. MORRIS,
Normal School, Warrensburg, Mo.

On page 686 in SCHOOL SCIENCE AND MATHEMATICS for November, 1916, the following statement is found: "Notwithstanding the increased importance of science as a factor in everyday life, it is a fact well known to students of education that the percentage of students studying the older sciences in our public schools is on the decline, and has been on the decline for twenty years."

Some one has said: "Facts are stubborn things." Since this is so, I shall not attempt to refute the above statement but seek for reasons why it is so.

I hope that I am not an alarmist; and yet there is cause for alarm when a formal subject like algebra holds its own while the sciences fall off. It is hard to believe, when we consider that the age in which we live is predominantly scientific. The part that science plays in modern life and all forms of modern industry is so well known to the general reader that it needs but mere mention. During the last hundred years the progress in science and industry has been very marked. The number of students in our engineering schools has increased rapidly; and yet, in the face of these facts, the older sciences, strange to say, have not held their own in our public schools.

Various reasons that are not derogatory to science can be given for this state of affairs. Many students who have done no laboratory work and therefore do not know its value are liable to regard it as irksome. I can very distinctly remember my own feelings in the matter. When I was a student at the Millersville (Pennsylvania) State Normal School, botany was *required* in the junior year. For the field and laboratory work each student was required to collect, name and mount fifty flowering plants, and to analyze and make drawing of twenty-five plants. Had the course been *elective*, the relatively large amount of time required outside of the regular recitations would have scared me away from this course.

Many of our students here do not elect science because they have the notion that if they do so they will not have time for the "school activities," on account of the laboratory work. This is especially true of those students who are doing some outside work to help defray expenses. Again, in most schools today the science teachers make their programs out in double

periods on account of the laboratory work. This means fewer classes; and, if the elective system is used, it will mean more conflicts for the students in classifying. Each of these factors reduces the number enrolled in the science departments.

During the past fifteen years the vocational element has gained a prominent place in our educational system. Personally, I welcome vocational education; yet, at the same time, I know it has tended to reduce the numbers enrolled in the older sciences. At least, it has in Missouri. In Missouri, today, two units of science are generally required of students graduating from first class high schools. Outside of the large city schools it is generally understood that one of these units will be agriculture. I am not questioning the validity of this. I fully realize the value of agriculture; but it seems quite natural that the older sciences should fall off in numbers when we consider that they share the time and credit formerly allotted to them with a subject so widely studied as agriculture.

I, for one, am not ready to attribute the falling off in the older sciences in the high schools entirely to the nature of the subject matter and to poor teaching; however, if it be true, as most writers on education at least infer, that the falling off is due largely to the nature of the subject matter and to the method of presentation, is it not high time for some readjustments to be made?

In pointing out some changes that I feel are needed, I shall limit myself to my own subject—physics. The argument that our high school physics is not connected closely enough with the daily life of the student is valid. We do not deal enough with "real situations." Read the preface to most any text on high school physics and you will probably find a statement somewhat like the following: "The student and his daily experiences have been uppermost in the author's mind." This is undoubtedly the right plan; but a careful examination of our high school texts will show that this plan has not been carried out in all cases. It seems hard—almost impossible—to break away from tradition; and hence much of our high school physics is still dilute university physics.

To cite a concrete case, take up the work on light. The study of light because of its part in everyday life, should be very interesting; but it is not always so. It is not unusual to see the teacher start with water-waves and ripples and from these "readily pass" to electromagnetic waves—rather a large

step for beginners. Would it not be more fitting to start the subject of light with some homely problem as "Lamps and Reflectors"? This will lead to a study of the first cost, the energy used, the amount and kind of light given out, etc. Incidentally the student will learn various optical terms, straight line propagation, photometers and their adjustments, the law of reflection, etc. In place of spending so much time in tracing light through lenses with *pencil* and *paper* why not take up a problem like this, "A Photograph for the 'School Annual' "? This will lead to a study of the parts of the camera, the pin hole camera with and without a lens and how images are formed. Some individual experiments or classroom demonstrations with lenses will be necessary; but the experiments *now* are made to answer definite questions and to furnish information that is immediately needed. The effect of light on certain salts may now be tried. The value of the camera to science and art should be pointed out. Certain members of the class may be assigned readings for a brief report on the history and development of photography.

Space forbids a discussion of "project teaching." I think it is Professor Woodhull of Columbia University who says: "All science is project science." I have heard Professor Strayer of the same school on two different occasions convey about the same idea. In the large high schools where experienced and well-trained teachers are employed and are required to handle but one subject, the method seems admirable; but in the smaller high schools where a teacher handles physics, chemistry, an overflow class in mathematics and probably coaches the boys in outdoor athletics, serious objections may be offered to this method. In such cases it is doubtless preferable to choose a good textbook.

Coming back to the subject of light, we spend too much time on refraction and too little on color, illumination, home decoration, etc. Often in our work on light we leave the earth and soar into the realm of the ether. I must acknowledge my guilt here. A few years ago in one of the classes in light I took a little time off to tell the class about J. J. Thomson's fibrous ether, Lodge's massive ether, Larmor's ether as a basis of matter, etc. After class one of the boys hailed me with this question, "Is that the stuff you buy at the drug store?" I immediately reached the conclusion that in elementary physics, at least, it is best to remain on sure footing.

It is not only in the subject of light that we fail to connect

the work with the student's past experience and his future needs; the same is true in electricity. We talk fluently about "a circuit." We have the students recite in parrot-like fashion amperes = volts / ohms. Can't the student get more by dealing with a "real situation" which is readily afforded by electric light circuits or electric stove circuits? I don't wish to infer that the aim is to make an electrician of the student; and yet I do believe that a student completing high school physics should know something about the installation of electric light and telephone circuits, as they are very likely to be part of his present and future surroundings.

In my judgment too much of our laboratory work in electricity is done with toys. Many of our high school students can tell much about "ebonite" and "cat's fur"; but if they were given a real problem, say the installation of a bell-system in an eight room school building, they would be like the girl who encountered a door-knocker for the first time. After she had looked at it intently for some time the lady of the house started to show her how it worked. She was not permitted to do this for the girl at once informed her that she knew what it was and how it worked but that she couldn't find the bell in it.

Likewise many of our high school students can tell all about the specific gravity of "a liquid"; but how many would be able to tell if the milk had been "watered"? Using the language of Dr. Leonard P. Ayres, "The greatest problem that the schools are facing is the lack of intimate relationship between the work of the schools and the work of the world."

From what I have said you will infer that I wish all the time spent on so-called "practical" subjects. No, I do not. It is impossible to draw a hard and fast line between pure and applied science. Those interested in the relation of these should read Gregory's book, "The Spirit and Service of Science." Personally, I think it is well to avoid extremes both in the practical and the cultural aspects of the subject. I agree with Professor Lewis in his address before the N. E. A. in 1915 on "Pure Science." He says: "We are likely to forget that children are not materialistic or utilitarian. They have imaginations which we should develop, not stifle. There is in every healthy child an innate curiosity about his surroundings which demands satisfaction, and which if developed and encouraged is the surest passport to knowledge and power. Often the colors in the soap bubble may arouse more interest than a pulley or a gas engine."

In the choice of subject matter, opinions vary widely. Some of our best known writers on education, as Professors Dewey and Bagley, have laid down some broad principles to govern the selection of subject matter. Twiss, in Monroe's "Principles of Secondary Education," enumerates several of these principles. If we knew definitely the purpose of the high school physics, the question of subject matter would be easier to handle; but our ideas of education have changed so much in the last ten years that we find great diversity in the opinions expressed concerning the purpose of the course in high school physics. While it is perhaps impossible to lay down hard and fast principles governing the choice of subject matter in all cases, high school teachers will do well to keep in mind Professor Dewey's two words, "real situations."

The second objection that may be offered to our present high school physics is in measurements and units. Lord Kelvin in his "Popular Lectures" made this statement, "I often say when you can measure what you are speaking about and express it in numbers you know something about it." The average teacher of high school physics has certainly accepted this at face value. I am not sure that Kelvin ever meant this to apply to beginners. Franklin, formerly of Lehigh University, takes quite a different view. He says: "My experience is, most emphatically, that a student may measure a thing and know nothing at all about it; and I believe the present courses in elementary physics, in which quantitative laboratory work is so strongly emphasized, are altogether bad." In spite of Franklin's statement, most laboratory manuals for high school physics introduce the beginner to exact measurements to be made and recorded in new units. The student enrolls in the physics class because he is interested in electric lights, telephones, automobiles, airships, motor-boats, submarines, etc. In place of cultivating this interest—a most precious possession—we ask him to measure to the second or third decimal place the diameter of "a cylinder" with a vernier caliper or a micrometer screw. I realize measurement has its place in all courses in physics; but the whole of physics is not exact measurements. Twenty years ago it was commonly accepted that the new discoveries in physics would be found in "the sixth decimal place." Right in the face of this view came the revolutionizing discoveries of Röntgen and Becquerel, neither of which was found in "the sixth decimal place."

Not only do we insist on exact measurements but also these measurements are to be recorded and thought of in new units. I have tried to teach beginners in physics for eleven years and I believe the one thing that has retarded my progress more than anything else is the unit situation. I am an ardent advocate of the metric system for general use; and yet I frankly confess I wish it would either come into general use or drop out entirely. I shall waste no time in arguing the superiority of the metric system when *mastered* (it is decimal, the unit of mass is logically derived from the unit of length, etc.); but it is not an easy matter to connect the work in beginning physics with the student's past experience, for he has had no experience with dynes, ergs, watts and maybe not even with centimeters. Where the metric system is taught in the grades, much of the work consists in defining the metric units in terms of the English units and then in drilling in multiplication and division by making use of such converting factors as 39.37, 15.432, etc. Some teachers have reached a point where they question the advisability of starting with metric units. The centimeter and the gram are all right; but I am convinced that such units as the dyne and the erg have no place in high school physics. Those who contend for the dyne base their argument on its use in defining the electrostatic unit quantity of electricity. If this is the only argument, we need not keep it. Try the average beginner in electricity with three systems of units and you will be as much discouraged as he is.

I shall put my third objection in the form of a question. Is not physics placed too far along in the course? The purpose of this is to allow ample mathematical preparation. To many high school teachers physics is merely problem solving. It is simply a subject in which students are expected to exercise mathematical skill. It is a case of history repeating itself in miniature, for we remember how some very noted French mathematicians about a hundred years ago, used electricity as a field in which to try out their analytical skill. Had it not been for Faraday, who could not read their mathematical language, electricity might have been added to the mathematical department. The only mathematics really needed for elementary physics is arithmetic, simple equations in algebra, and the geometry of such common figures as the triangle, parallelogram, circle, etc. What is the objection to starting the work in the tenth grade? Teachers interested in having students start

the work earlier than the third year of the high school should read Professor Millikan's article, "Wastes in Science," published in SCHOOL SCIENCE AND MATHEMATICS, March, 1916.

Perhaps the worst objection to our high school physics is the method. We start in with *definitions* and *general statements*. What is left for the student? Let me illustrate by a recent lesson I witnessed in high school physics. Here was the experiment for the day, "Verify Hooke's law." Many teachers today question the advisability of giving Hooke's law to high school students. Were I teaching in a large high school with a class made up mostly of boys I should not hesitate to include it in the course; but not in the form as stated above. Without arguing the matter, let us decide to give it. How? Start with a concrete problem in the form of a laboratory demonstration (I say laboratory demonstration because it is probable that there will not be apparatus enough for each student to perform this experiment individually). Take a steel rod four feet long and one-third of an inch in diameter (other dimensions may be used) and fasten it in a torsion lathe; now find the weight that must be placed in the scale pan to twist the rod, say, one degree, two degrees, three degrees, etc. In like manner find the weight required to elongate a spiral spring, say, a quarter of an inch, half an inch, etc. In like manner take up the bending of a bar or rod. With these three simple demonstrations in which the students have taken a part they will easily arrive at the general statement, "The strain is proportional to the force producing it." Next we are ready for the application of this law in structural work. Now, perhaps, it is only fair to Hooke to tell the class that he enunciated this law more than two hundred years ago. A few minutes may be spent profitably on this interesting character. The relation of Hooke to his contemporaries may be touched briefly. Biography affords an elegant opportunity for vitalizing physics. Unfortunately it is too little used. By this method all laboratory values sought are needed in the solution of a definite problem. If rightly handled, the class is in the attitude of investigators. If possible, keep them in this attitude. I am not arguing for Hooke's law; there is plenty of material without it; but I believe it can be presented with profit if a method somewhat like the one briefly sketched is used.

If there has been a falling off in high school science as the Commissioner of Education says there has, it seems to me it is up to us as science teachers to find causes and remedies.

NOTES ON BIOLOGY TEACHING.

By B. C. GRUENBERG,
Julia Richman High School, New York City.

ON FIRE AND OXIDATION.

The concern of the student of life with *fire* is taken for granted by every modern teacher of biology. The subject of oxidation lends itself particularly well to the teaching of the *experiment* as a method of inquiry.

A candle flame furnishes the most convenient fire; a large candle that will stand steadily is to be preferred to the small size.

The *flicker* of the flame suggests that burning liberates *motion* in addition to light and heat. It may well be that this motion is imposed upon the flame by air currents, as is the case with the trembling of leaves on a tree or the movement of a shirt on a clothes-line. The doubt may be resolved *by trying*—that is, by experiment. Emphasize the important fact that we have here a problem, the solution of which we shall not seek in authorities or in recourse to other people's beliefs and opinions, but in the *materials* and *forces* at hand. Have the problem formulated clearly by the pupils, that there may be no ambiguity as to just *what* we are trying to find out. The next question is, *how* shall we proceed to find out? Several methods will be suggested; a choice will be made depending in part upon materials available and in part upon the nature of the problem. It may be that two or three proposed methods are equally suitable and equally available.

Make a record or schedule of the materials used. Make a separate schedule of what is to be done with these things.

The generalized scheme for the experiment is *to shut out* air currents. A lamp chimney has the advantage that it may surround the flame on all sides and that it is transparent. Whatever method is used for shutting off the air currents stops the flickering. The result may be checked by having two candles side by side, with only one exposed to the experimental variable, that is, the-shutting-off-of-air-currents. The difference in behavior between two flames under the experimental conditions may be sufficient to satisfy the pupils with the *conclusion* that the flicker is due to outside disturbance.

If there is any disposition to discuss the matter further, be careful to remove the chimney before the flame is extinguished. It may be put on and taken off, as it were casually, several times

before the question is closed. As the discussion nears its end, leave the chimney over the candle and the flame will expire—if the edge of the chimney fits the top of the desk closely. This will at once suggest new questions; and many of the pupils will be prepared to explain that it is the *exclusion of the air* that resulted in the dying out of the flame. But before that can be taken up, make a complete record of the first experiment, insisting upon logical sequence and clear analysis rather than upon the mechanical form of the record.

The following points should stand out clearly whatever discussions may be used.

1. *The problem:* The question to be solved.
2. *Materials and apparatus:* What was used.
3. *Operations performed:* What was done.
4. *Results:* What happened, what phenomena or changes were observed.
5. *Conclusion(s):* The answer to the question so far as it may be inferred from the *results*.

In insisting upon a correct record of the first experiment, we must shift the emphasis from the performance as an interesting "stunt," to the *argument* involved in the formulation of the problem, in the selection of materials and procedure, in selecting the significant elements from the results, and in drawing conclusions. In other words, we must establish a standard routine for *thinking* about problems. To establish the routine now is to save time later.

A second experiment, suggested by the expiration of the enclosed flame, centers on the question whether the flame *uses up* something in the air, or *gives off* something that is essential to the burning. The air being invisible, we must find some means of showing the increase or decrease in the volume of air. It may be that after several suggestions from the pupils it will devolve upon the teacher to find a feasible plan. A cylinder large enough to go over the candle and closed at one end, inserted over the lit candle standing in a dish of water, will meet all the conditions. If the former *gives off* gas (es), bubbles should be forced through the water out of the cylinder. But if the flame *uses up* part of the air, something different must happen. The possible results should be anticipated as part of the argument or mental preparation before the operation is actually performed, but with the apparatus in hand.

Some of the pupils will probably jump to the conclusion that the flame "uses up" part of the air. But we must not be too sure. It is conceivable that both processes are going on at the

same time but at different rates. Here is a problem for the chemist—to identify the gases concerned.

When the cylinder is finally placed over the lit candle, the flame begins to "fade," it flickers a few times, and finally it expires. In the meanwhile, the level of the water inside the cylinder changes in a way that indicates a reduction in the amount of gas enclosed. We may also observe the condensation of moisture on the inside of the cylinder. We may also notice the thin column of smoke ascending from the wick. Which of all of these phenomena are significant in relation to our problem? Have pupils restate the question; this must be constantly in mind to avoid distraction by the many results or changes brought about in the course of the experimental process.

What is indicated by the change in the level of the water? Probably that something in the air has been removed by the action of the flame. By means of a ruler held alongside the cylinder, it may be possible to get an approximation of the proportion of air "used up."

But let us not overlook the possibility that something may be present in the air that was not there before. We shall have to come back to the question whether the flame gave off something. There is the smoke, for example; and perhaps there are some invisible fire-products. We may need the assistance of the chemist to answer these questions. We may be certain only, at this time, that *something has been taken from the air by the burning.*

As to the chemical nature of the remaining gas or gases, we should need some knowledge of chemistry to proceed farther. It is futile to test this air further with relation to fire—as some of the students are almost sure to suggest, and as many teachers actually do. For the failure of a flame to burn in this residual air cannot tell us anything that we did not already know. The teacher, drawing upon his fuller experience, produces a *reagent* —a substance that *reacts* distinctively with the various gases; in this case, lime water. It is just as well to explain that this is the same kind of lime water as is sometimes used in the baby's milk bottle. It is prepared by shaking up some calcium oxid (unslaked limed) with water and filtering through paper. Keep the lime water in tightly stoppered bottles; cork is better than glass but if glass stoppered bottles are used, smear a little vaseline on the stopper to make sure of an airtight joint that will not become caked.

Place a little lime water in the bottom of glass cylinder similar to the one used in experiment. Place the palm of the hand tightly over the open end of the cylinder and shake up vigorously. Place a little lime water in the cylinder taken from over the expired flame and shake up as before. In this jar the lime water turns cloudy or milky. This shows us at least that the two masses of "air" are different, although it does not tell us just what the difference is. We may, however, conclude that the burning process not only removes something from the air but also sets free something that was not there before.

The question may here be raised as to the relation between the products of combustion and the fuel on the one hand and the materials removed from the air on the other. It is a reasonable *hypothesis* that the product, like the visible "ash" of some other fires, is either (a) some portion of the fuel thus set free; or (b) a portion of the fuel or of the air somehow "modified," or finally (c) a *new combination* of materials containing elements from the fuel, from the air, or from both.

The technique of testing these variations of the hypothesis is rather too complex for the schoolroom. We can test, however, the supposition that the product of a burning contains fuel substance plus air substance. For this purpose we must have a fuel which on burning yields a product that is easily gathered and weighed. We use magnesium ribbon—magnesium because the product of its composition is solid, and ribbon because it is convenient to handle. On one platform of a trip balance place a strip of ribbon about eight inches long and a large funnel closed with cotton wool in the stem. A wire loop or hook may be hung into the funnel before adjusting the balance. Hang the magnesium ribbon from the loop and ignite with alcohol or Bunsen flame; replace funnel immediately upon platform of the scale. If the operation has been carefully conducted, the accumulated "smoke" or "ashes" will be found to *weigh more* than the original ribbon of magnesium. Since the addition to the solid matter on scale platform could have come only *from the air*, we are tempted to conclude that the air stuff which takes part in burning combines with something in the fuel.

From these experiments the pupils may learn a great deal that is worth knowing about the relation of air to fire. It is much more important, however, that occasion be found for teaching the meaning of an experiment as an instrument for intellectual advancement. In the experiments used it is possible

to bring out the idea that problems can be solved by concentrating phenomena under control instead of waiting to learn by "observation" of casual phenomena which come in the course of random experience. It is possible also to learn that a scientific "explanation" takes the form of an hypothesis which must be verified or tested and which is valid only so far as it fits in with experience. It is possible in the third place to learn from these experiments the idea that every question answered in a scientific way gives rise to new questions.

In general, it is well to have the materials to be used in the day's work readily accessible in the laboratory or recitation room, but *not laid out.* When you—that is the teacher *and* the pupils—decide that a lamp chimney or a funnel would be desirable, the teacher's resources must be equal to the occasion; but no matter how carefully the teacher has prepared the day's demonstration, the procedure should never give the impression of being "cut and dried" in advance. Exceptions should be made for demonstrations that involve rather elaborate arrangements or that take more time for setting up than the usual session allows. In that case, however, there is either no pretense that the experiment is performed in response to a problem which has arisen in the class; or, if you have led up to the problem, the *plans* for the experiment may be agreed upon at one session, with the understanding that the preparations will be made in anticipation of a future meeting of the class. Above all, the experiment is never to be a school substitute for a circus or a performance in magic.

LIBERTY LOAN SUBSCRIPTIONS.

Failure of rural communities to subscribe relatively as liberally as the metropolitan districts was generally ascribed not to lack of patriotism but lack of thorough organization and intensive campaigning. In future campaigns every agency will be used in the rural districts as well as in the cities. The women's organizations will be very active and hearty cooperation between them and the other organizations is assured.

Educational work in the schools of the country is to be stressed, and through the schools generally, therefore, educational campaigns are to be carried on all over the country not only during Liberty Loan campaigns but in the intervals between.

Enthusiasm, patriotism, and earnestness must be characterized in every American citizen not only at present but especially when the next Liberty Loan Campaign is on in order that the loan may be raised with the least possible effort.

BIOLOGY IN THE HIGH SCHOOL.

By G. H. Oberteuffer,
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To a biologist, a discussion of the values, aims and purposes of a high school course in biology is superfluous. Any one of its numerous values in itself would be reason enough for its incorporation in the curriculum, so great is his enthusiasm and love of his subject. But to the layman, even to the average educator, much more is needed for the justification of such a study. Let us review then the values and aims of biology and later discuss the content of our own particular course.

Herbert Spencer divides the activities of life into those concerned with self-preservation, those concerned with earning a livelihood, those concerned with the rearing of offspring, those which minister to the regulation of conduct in social and political relations, and those which minister to the gratification of our tastes and feelings. He then proceeds to prove that science more than any other study better enables us to perform these activities. In other words, if these five functions constitute our active life, and education is "the preparation for complete living," science is the most important part of our education.

But we do not want to argue that science is the *most* important part. Rather, that science, particularly biology, is a very important and a decidedly necessary part.

Science as taught today has the following abstract values: It trains the child in close observation; it develops the powers of organization, comparison and inductive reasoning; furthermore, science is a great developer of the imagination, and lastly it provides valuable information.

Biology as a science has these values. Who observes more closely than the student of nature hunting for the pupal or resting stage of the butterfly on the under side of a forest leaf? Who has keener powers of observation than the nature lover who is trying to determine the message conveyed from one little red ant to another in the antennae salute? The laboratory work in biology, leaving to the student the problem of drawing conclusions, necessitates the development and use of reasoning powers. What study can be a greater stimulus to the imagination than one which will prompt a child to say, "I'd like to be a little water beetle for a day just to see what they think about." And as to yielding valuable information, one has only to reflect that our modern study of forestry is only a branch of biology in order to

appreciate this value. So we see that biology admirably fulfills the four greatest abstract values of science.

Before going further into a discussion of the concrete values of biology, let us gain some idea of the scope of the subject. Biology is defined as the "Science of life." Its two great subdivisions are botany and zoology. But no less are the subjects of forestry, animal husbandry, crop husbandry, agricultural technology, bacteriology, fishery and floristry, essentially divisions of biology. Physiology is purely biology, as are its allied subjects, anatomy, hygiene and sanitation. The more detailed physiological branches such as: neurology, the study of nerves; osteology, bone study; pharmacology, the study of medicines; surgery, histology, tissue study and embryology are also subdivisions of biology. Psychology is the latest biological study to gain recognition.

When we realize that any study of life or living things is biology, we have an enormous conception. And when we consider that life is simply the working out of nature's laws, biology becomes to some extent nature study, the one course from the greatest teacher of all. As Longfellow said:

> And Nature, the old nurse, took
> The child upon her knee
> Saying, "Here is a story-book
> Thy father has written for thee."

Or, in the less poetic words of the greatest adolescent psychologist, G. Stanley Hall: "To know nature and man is the sum of earthly knowledge."

Let us consider the specific values to be derived from the study of biology. In this day of commercial supremacy, perhaps it is fitting to mention the economic value first, although to me this is not the most important. A study of biology has an economic value which is of utmost importance to civilization today. What is drawing our nation into the present European conflict? Germany's attempt to prevent her enemies from obtaining food, the production of which is economic biology. What will eventually defeat Germany? Starvation! The prevention of which is also economic biology. The United States owes its martial immunity today to the fact that it is self-supporting. Our government bureaus of agriculture, forestry and sanitation are biological institutions. Our manufacturing and commerce have attained a wonderful growth, but they are based upon our agriculture, which is in turn nothing but the working out of nature's laws.

Such vital subjects as pure air, pure water, bread making, shade trees, forest conservation, disease prevention, game birds, fungus and bacterial growths and weeds are studied in economic biology. In one year the cost of our entire school system in the United States is 285 million dollars, while the crop destruction by insects is 300 million. When we ponder such figures as these, the economic value of biology is clearly seen.

The aesthetic value is also great. The love of the beautiful forms a large part in the life of us all. Flower culture is an evidence of an instinctive love for beauty. This love is as old as man himself and was expressed in flower culture by the ancients. The beautiful hanging gardens of Babylon in 680 B. C. furnish us an example from history.

Where outside of nature do we find anything as beautiful as a violet? What man-made shade of yellow rivals the daffodil? And even the commonly despised pond scum, when placed under the microscope shows a wonderful spiral arrangement of glistening emerald bonds.

"Consider the lilies of the field, how they grow: they toil not, neither do they spin, and yet I say unto you that even Solomon in all his glory was not arrayed like one of these."

Much of our literature and poetry has for its theme, nature. The works of Bryant, Wordsworth, Longfellow, Tennyson, Lowell, Whittier, Helen Hunt Jackson, Lucy Larcom, Burroughs, and Thoreau will prove this.

Biology has an ethical and social value, in that the knowledge obtained therein helps a child in the determination of what is right and wrong. No student of biology maliciously robs a bird's nest or is guilty of cruelty to animals. Animal study awakens a sympathetic interest and love for all animal life and creates a realization not only of the brotherhood of man but of the broader brotherhood of all animals. The shade trees, beautiful lawns, floral displays, porch boxes and botanical gardens in any community are the result of the social value of biology. The pride in the outside appearance of one's home is a value not to be neglected. Caring for gardens and animal pets teaches the child habits of industry, carefulness and unselfishness.

To illustrate further the social value, consider the lessons we may draw from the ant colony. The type of civilization found among the ants in some respects surpasses human civilization. The ant community is the very personification of industry. There are no lazy ants. They are born to work and each indi-

vidual performs his task day after day with no bosses or overseers, nor any compensation for his work other than the aid rendered to the colony. The division of labor is remarkable; certain members of the group are specialized as workers, others as warriors, sentinels, burden bearers, engineers, nurses, but no lawyers, jailors, legislators, administrators or doctors. In an ant colony the morality is so good that policemen and jails are unnecessary. Law makers are of no avail because ants do not break nature's laws. And doctors are superfluous when we consider the physical development of the individuals. A man with the proportionate strength of an ant could bear a ton of coal upon his back. This enormous strength is best shown by the ant engineers. When the colony is on the march these are in the advance guard and when a stream is reached they make a living bridge across it with their bodies and remain suspended so for hours, while thousands of their comrades march across on their backs. Then when the last members are over, the engineers hurry to the front ranks to repeat the service at the next stream. Another virtue of the tiny ant is patriotism. Not one ant in the whole colony hesitates to fight and die if necessary in the defense of his home.

Thus biology has an economic, aesthetic, ethical and social, and religious value. Does any other subject have such a diversity? Froebel conceded to nature study the honor of saving education from becoming hollow, empty and artificial. And when we realize that nature has built up the human brain to its present level and then try to conceive of a plan of education that leaves nature in the background, we are quite apt to be laying frail foundation for the building of intelligent human character.

Our own course has been organized on a basis of emphasizing an aesthetic appreciation of the wonders and beauties of nature. Admitted this is not practical, and cannot be turned into money, yet we have other departments well organized and equipped to tend to this need. But in no course, with the exception of art and possible literature, have we an equal opportunity of creating this aesthetic love and appreciation of the beautiful and wonderful. The child today is apt to so overdevelop in the practical, money making and livelihood obtaining lines that his future will be a sordid, mechanical existence, devoid of anything but artificial pleasure. Not that we criticize the industrial, commercial or any other department of work; all are necessary if education fits a child for complete living.

Secondly, we attempt to develop powers of thinking, reasoning and observation. Our laboratory work and field trips minister to this end. The economic and socializing values are of next importance to us in our teaching. The religious value would be spoiled if we attempted to teach it. But from time to time as we study and investigate, this great truth comes to the child as an inspiring realization.

A very brief outline of the content of our course is as follows:

1. A series of elementary, introductory discussions on the purpose and scope of biology, elements of physics and chemistry to explain environment, composition of material, etc. The aim is to arouse interest and give the student the tools with which he will later work.
2. A study of the flower; roots, stem and leaves.
3. Photosynthesis (starch-making in the leaf) as the elementary food factory of the world.
4. Pollination, as the mutual help of nature's forces.
5. Fertilization and germination as part of nature's plan.
6. The entire plant kingdom; a study of type forms, to show variation and diversification.
7. A study of plant reproduction from simple fission to pollen and ovule union or fertilization, to illuminate the function of reproduction in a new and proper light.
8. The relation and interdependence of plants and animals, including the similarities of the microscopic organisms.
9. The detailed study of animals from the most lowly one-celled forms up to man, from the standpoint of the nine vital functions common to all animals: food-taking, digestion, sense organs, locomotion, excretion, respiration, nervous control, reproduction and circulation.

This study shows clearly the universal brotherhood of all animals and contributes to all of the aims of biology. Incidentally, it solves the problem of sex instruction in the high school in such a clean and indirect, yet efficient and unoffensive way that there is no need for any additional instruction. The student realizes that it is a necessary God-given function, common to all forms of life on earth.

The entire year's work is supplemented by laboratory experiments with real material, organized on the plan of letting the student do the work and discover the facts. Field trips are an integral part of the instruction and are made inspirational and instructive.

A FRIENDLY NOTE ON DR. HILTON JONES' ARTICLE.

Dear Mr. Smith:

I am so acutely aware of my own unimportance that I hesitate to ask if you will permit the use of SCHOOL SCIENCE AND MATHEMATICS for a very friendly answer to certain remarks of Dr. Jones in his worthy article found in SCHOOL SCIENCE AND MATHEMATICS for January, 1918. The fact that you have before this permitted certain of my articles to appear there is the only reason why this particular lamb dares to roar back at the lion.

I am Eastern by birth, training and desire. The West, especially South Dakota, has always appeared too drafty for me.

Genius is impetuous. Nothing is impossible for genius to imagine; not even the securing of men with specialized graduate work to take poorly paid positions far from the soothing influences of the symphonies, libraries and jazz bands of the "bean eating," "effete" East.

As Doctor Jones states, there is a vast difference between teaching science to high school students "to make scientists" out of them—although the majority of them will never use articles more scientific than a vacuum cleaner, nor make demands on their chemistry more than to see whether the water is hard or soft by the soap test—and teaching so that snobbish tendencies toward a foolish culture aim are immediately apparent.

I doubt if the West as a whole intends to make scientists of all high school students, even as it comes to me as a surprise that the "effete," "bean eating" East sees in the modern sciences only a chance for cultural development.

This lamb roars from a well equipped laboratory and holds his tiny sheepskin—proving graduate work—as fitting him to speak at all, modestly in front of him. Someone had to come to the rescue, or I am certain that many Eastern readers would always have a feeling of absolute humiliation and sorrow for their condition after reading the second sentence of the third paragraph from the end, or limit of Dr. Jones' article.

Sincerely,

H. L. CHASE,
Stevens High School, Claremont, N. H.

FORESTRY EXHIBITS AND SLIDES LOANED BY THE GOVERNMENT.

Traveling exhibits of woods, of charts, maps, and diagrams concerning forest products and of photographs on forest subjects and sets of colored lantern slides, accompanied by lecture outlines, relating to trees and forests are loaned by the Forest Service of the U. S. Department of Agriculture, Washington, D. C., free of charge except for transportation. The wood exhibits consist of sixty-four samples of commercially important woods of the United States, maps showing the region in which each species grows, short statements of their principal uses and physical characteristics, charts and tables showing forest products by states, the rise and fall of the lumber industry, and the percentage of lumber supplied by different regions, and maps of the natural forest regions of North America and the national forests.

The photograph exhibits contain forty-four or forty-eight large mounted photographs of forests of the United States, their use and preservation, and the administration and use of the national forests. These photographs are arranged in series, which form illustrated stories.

Both wood and photograph exhibits are placed on mounts measuring 16½ inches by 10 inches, which are arranged on panels, containing four

mounts each. In the upper corners of each panel are eyelets for hanging. One entire exhibit covers a wall space about 4½ feet high and 14 feet long.

Sets of colored lantern slides of fifty or more slides each are available on the following subjects:

"Forestry in the United States."
"Work of the Forest Service."
"The Farm Woodlot" (for Eastern States).
"Tree Windbreaks" (for States of the Central and Middle-South Regions).
"Nature Study and Forestry."
"Botany and Forestry."
"Manual Training and Forestry."
"Geography and Forestry."
"Agriculture and Forestry."

A syllabus for a lecture accompanies each set.

Slides are loaned for short periods, usually of one or two weeks, and the exhibits for three weeks to schools, clubs, lecturers, and others engaged in educational work, on condition that the borrowers pay transportation charges, be responsible for the material while charged to them, and forward it promptly at the direction of the Forest Service. Effort is made to arrange itineraries of exhibits so that borrowers will usually have to pay transportation only one way, and whenever practicable transfers are made between borrowers residing near each other. Ordinarily these arrangements are impracticable for lantern slides, and their transportation from Washington and return is paid by each borrower. The lantern slide sets, packed for shipment, weigh usually less than fifteen pounds, the exhibits less than twenty-five pounds.

Applications for these materials should be made to the Forest Service, Washington, D. C. Applicants should state that they agree to the conditions on which loans are made, as outlined above.

A PROBLEM IN REGULAR POLYGONS.

By M. H. Pearson,

Montgomery, Ala.

Certain books in mechanical drawing give the following method for inscribing a regular n-gon in a circle, but fail to admit that, except for special cases, it only approaches accuracy.

On the diameter AB construct the equilateral triangle ABC. Divide the radius AB into n equal parts. Measure off BD on BO equal to 4 equal parts. Draw CD to cut the farthest side of the circle at E. Then BE is the proposed side of the n-gon.

Now, the equation of the circle of radius r, referred to OC and OB as axes of coordinates, and the equation of the line CE are, respectively,

$$x^2+y^2 = r^2, \tag{1}$$

and

$$(n-4)x+ny\sqrt{3} = r(n-4)\sqrt{3}. \tag{2}$$

We see that

$$\overline{BE}^2 = x^2+(r-y)^2 = 2r^2-2ry. \tag{3}$$

Solving (1) and (2) for y, and substituting in (3), we have, after simplifying,

$$\overline{BE}^2 = \frac{r^2(n^2+4n+16\pm\sqrt{n^4+8n^3-144n^2+512n-512})}{2(n^2-2n+4)}. \tag{4}$$

For $n = 3, 4, 5, 6, 8, 10, 12$, the values of $\overline{BE}^2$ in (4) are, respectively $3r^2, 2r^2, r^2/38(61-\sqrt{73}), r^2, r^2/13(14-2\sqrt{10})$, $r^2/84(78-11\sqrt{17})$, and $r^2/31(26-4\sqrt{29})$.

As will be seen, we use the positive sign of the radical in (4) for $n = 3$, either sign for $n = 4$, and the negative for n greater than 4. That is because E is below the x-axis, on the x-axis, or above it, according as n is 3, 4, or greater than 4.

Incidentally, the radical is imaginary for $n = 1$ or 2.

These results for $n = 3, 4, 6$, are the squares of the well-known values of the sides of the regular triangle, square, and hexagon. The other results are only close approximations.

PROOF OF GEOMETRICAL THEOREM.

By TAKESHI OMACHI,

In Sendai, Japan.

Another proof of the theorem that in any triangle, the product of two sides is equal to the product of the segments of the third side formed by the bisector of the opposite angle plus the square of the bisector.

Let AD bisect the angle A of the triangle ABC, cutting BC at D; then,

$$AB \times AC = DB \times DC + \overline{AD}^2$$

Produce BA to E, making AE = AC, and join CE. Let a parallel through A to BC meet CE in F, then we have DC = AF, AD = FC. The triangles ABD, EBC are similar, and give,

$$\frac{AB}{BE} = \frac{BD}{BC} = \frac{AD}{EC},$$

$$\text{whence } \frac{AB}{BE-AB} = \frac{BD}{BC-BD} = \frac{AD}{EC-AD},$$

$$\text{or } \frac{AB}{AC} = \frac{BD}{DC} = \frac{AD}{EF},$$

$$\text{hence } \frac{AB \times AC}{\overline{AC}^2} = \frac{BD \times DC}{\overline{DC}^2} = \frac{\overline{AD}^2}{EF \times AD},$$

$$= \frac{BD \times DC + \overline{AD}^2}{\overline{DC}^2 + EF \times AD}.$$

Since the triangle ACE is an isosceles triangle,

we have $\overline{AC}^2 = \overline{AF}^2 + EF \times FC$,

therefore $\overline{AB}^2 = BD \times DC + \overline{AD}^2$.

WANTED.

Thirty-five cents will be paid for unmutilated copies of the October 1911 issue of this Journal. Send to the Business Manager.

PROBLEM DEPARTMENT,

Conducted by J. O. Hassler.

Crane Technical High School and Junior College, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics. Besides those that are interesting per se, *some are practical, some are useful to teachers in class work, and there are occasionally some whose solutions introduce modern mathematical theories and, we hope, encourage further investigation in these directions.*

We desire also to help those who have problems they cannot solve. *Such problems should be so indicated when sent to the Editor, and they will receive immediate attention. Remember that it takes several months for a problem to go through this department to a published solution.*

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages. In selecting problems for solution we consider* accuracy, completeness, *and* brevity *as essential.*

The Editor of this department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to the Editor. *Address all communications to J. O. Hassler, 2301 W. 110th Place, Chicago.*

546. *Proposed by W. W. Gorsline, Crane Technical High School and Junior College, Chicago.*

The following six groups of numbers A, B, C, D, E, F, comprise a well known game or "puzzle." Any number less than 64 is selected and the groups in which it occurs are denoted, e. g. 37 : in A, C and F. By adding the first numbers in the respective groups the number is determined as $1+4+32 = 37$. Find the secret of arrangement of numbers and possibly derive a formula of arrangement for n groups.

A

1	3	5	7	9	11	13	15
17	19	21	23	25	27	29	31
33	35	37	39	41	43	45	47
49	51	53	55	57	59	61	63

B

2	3	6	7	10	11	14	15
18	19	22	23	26	27	30	31
34	35	38	39	42	43	46	47
50	51	54	55	58	59	62	63

C

4	5	6	7	12	13	14	15
20	21	22	23	28	29	30	31
36	37	38	39	44	45	46	47
52	53	54	55	60	61	62	63

D

8	9	10	11	12	13	14	15
24	25	26	27	28	29	30	31
40	41	42	43	44	45	46	47
56	57	58	59	60	61	62	63

E

16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

F

32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

I. Solution by R. M. Mathews, Riverside (Cal.) Polytechnic High School.

In Vol. XIII, p. 119 (December, 1913), of this journal I published a note on these "Magic Number Cards," showing their secret and how to make them for other sets.

The key number on each card is a power of 2, the powers ranging from 2^0 to 2^5. Determine the powers of 2 whose sum equals a given number and place it on each card of the power involved. Thus, $37 = 2^5+2^2+2^0$.

If n be chosen as a base, represent the given number on the scale of n and mark it on each card of the power involved. However, a card will be needed not only for each power of n but also for 2, 3, 4, $\cdots$ $(n-1)$ times each power. Thus with base 5 we have $13 = 2 \cdot 5^1+3 \cdot 5^0$ and 13 is marked on the cards with "key number" $10 = 2 \cdot 5^1$ and on $3 = 3 \cdot 5^0$.

II. Solution by E. B. Escott, care of Kansas City Life Insurance Co.

The numbers at the corners are the successive powers of 2. Therefore, if the different numbers of the natural series 1, 2, 3, . . . are expressed as the sum of powers of 2, these will show in which tables they will appear. In other words, express the natural series in the binary scale.

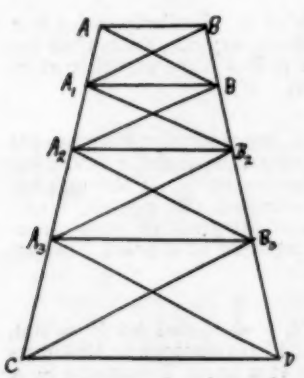
Decimal Scale.	Binary Scale. EDCBA	
1	1	Column A contains alternate 1's and zeros. Wherever a 1 occurs, the corresponding number in the decimal scale occurs in Table A. We see that only the odd numbers occur in this table. Likewise, from Column B, we see that Table B contains two consecutive numbers of the natural system, then two are omitted, etc. From Column C, we see that Table C contains four consecutive numbers of the natural system, commencing with 4, then the next four are omitted, etc.
2	10	
3	11	
4	100	
5	101	
6	110	
7	111	
8	1000	
9	1001	
10	1010	
11	1011	
12	1100	
13	1101	
14	1110	
15	1111	
16	10000	
.	.	
.	.	

Solutions to this problem were also received from ISIDORE GINSBURG, C. E. GITHENS.

547. *Proposed by Norman Anning France.*

The cap and sill of a high trestle bent are respectively 150 and 400 inches long. Find the lengths of three intermediate caps which are so spaced that the diagonal braces are parallel from top to bottom.

Solution by the editor.



$AB = 150$, $CD = 400$;
$AB_1 \parallel A_1B_2 \parallel A_2B_3 \parallel A_3D$;
$A_1B \parallel A_2B_1 \parallel A_3B_2 \parallel CB_3$.

Let $A_1B_1 = l$, $A_2B_2 = m$, $A_3B_3 = n$.

Triangles AA_1B_1, $A_1A_2B_2$, ... are similar.

Triangles AA_1B, $A_1A_2B_1$, ... are similar.

$$\therefore \frac{150}{l} = \frac{AA_1}{A_1A_2} = \frac{l}{m} = \frac{A_1A_2}{A_2A_3} = \frac{m}{n} = \frac{A_2A_3}{A_3C} = \frac{n}{400}.$$

Let $1/r$ represent this ratio. Then $l = 150r$, $m = rl$, $n = rm$, $400 = rn$, whence

$150r^4 = 400$, and $r = \sqrt[4]{8/3} = \frac{1}{3}\sqrt[4]{216}$.

$\therefore l = 191.68$, $m = 244.95$, $n = 313.02$.

Geometry.

548. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Three points A, B, and C start from S on the circumference of a circle to move around the circumference at uniform rates, a, b, and c, respectively. If length of the circumference is P and $c > b > a$ find the condition

that the first time they are together again shall be at S; also the time that is required for them to meet again at S.

Solution by the Editor.

Consider the second part first.

Let a, b, and c represent integral rates in units of distance per unit of time of A, B, and C, respectively (which assumes they are mutually commensurable). Let P represent units of distance in the circumference. Then P/a, P/b, P/c represent the time of one complete revolution for A, B, C, respectively. The shortest time required to meet again at S is L. C. M. of P/a, P/b, P/c which is P/d, where d is the G. C. D. of a, b, c. For, the L. C. M. of several fractions is the L. C. M. of their numerators divided by the G. C. D. of their denominators. (If $d = 1$ the time is P.)

Concerning the first part, we will prove the following:

Necessary and sufficient conditions that A, B, C, are together again before meeting at S are

$$b = a+ks, \qquad (1)$$

$$c = a+ls,$$

where k, l, s are positive integers and where s is not an integral factor of a. (According to the problem, of course $l > k$.)

Assume, for simplicity, that a, b, c have no common factor.

Let T be a point of meeting before coming together at S and let arc $ST = rP/s$, r and s prime to each other. Represent the number of revolutions for A, B, C, respectively, from the start until meeting at T by

$u+r/s$, $v+r/s$, $w+r/s$. (u, v, w positive integers.)

Since P/a, P/b, P/c represent the time for each revolution of A, B, C, respectively, then

$$P(u+r/s)/a = P(v+r/s)/b = P(w+r/s)/c, \qquad (2)$$

whence

$$av-bu = \frac{(b-a)r}{s}.$$

Since $av-bu$ is integral, $b-a$ is a multiple of s. Similarly, $c-a$ is a multiple of s and we have equations (1) as a necessary condition that the meeting point be at some point T before the points come together at S.

Conversely, if we assume equations (1), then

P/a, $P/(a+ks)$, $P/(a+ls)$

represent the time of one revolution for A, B, C, respectively; P represents time elapsed from the start until they are together at S; and a, $a+ks$, $a+ls$ represent the number of revolutions until together at S. If the number of revolutions for each be divided by s, the numbers a/s, $a/s+k$, $a/s+l$ thus obtained represent each a number (not integral) of revolutions such that the points A, B, and C, would be together at a point T where arc $ST = a/sP$.

Illustration:

Let $a = 7$, $b = 11$, $c = 17$ ($s = 2$, $k = 2$, $l = 3$) and let $P = 100$, say. To meet at S again A makes 7, B 11, C 17 revolutions in 100 units of time. They also meet in 50 units of time at a point T opposite S, A having made 3 1/2, B 5 1/2, C 8 1/2 revolutions.

Note: The argument is the same if a, b, c have a common factor, the notation merely being encumbered with an extra symbol.

549. *Proposed by Murray J. Leventhal, New York City.*

Given an equilateral triangle ABC and point P, so that PA = PB+PC. Show that the locus of P is a circle. (From a New York City examination for teachers.)

Solution by Nelson L. Roray, Metuchen, N. J.

Take the circumcircle of the triangle and let P be any point on the arc BC. Through C take a parallel with PB intersecting AP at M.

Then $\triangle MPC$ is equilateral and $PM = PC$. Also $\triangle AMC = \triangle BPC$ and $AM = BP$.

$\therefore AP = PB + PC$.

Take P′ any point outside the circle on AP.

Then in $\triangle BP'C$

$$P'C^2 = PP'^2 + PC^2 + PP' \cdot PC,$$
$$P'B^2 = PP'^2 + PB^2 + PP' \cdot PB,$$

and

$$P'C^2 - P'B^2 = PC^2 - PB^2 + PP'(PC - PB),$$

or

$$\frac{P'C + P'B}{PC + PB + PP'} = \frac{PC - PB}{P'C - P'B}.$$

Since $\angle BPA = \angle APC = 60°$, $PC - PB > P'C - P'B$,

$\therefore P'C + P'B > PC + PB + PP'$

$> PA.$

Similarly for any point on PA between A and P.

$\therefore$ The locus of P is the circumcircle of ABC, provided the algebraic sum is understood for $PB + PC$, due regard being observed for the signs of PB and PC.

A second solution was received from NELSON L. RORAY, *and one from* R. M. MATHEWS.—*Ed.*

550. *Proposed by Daniel Kreth, Wellman, Ia.*

Given the altitude and radii of the circumscribed and inscribed circles of a plane scalene triangle, to construct it and determine its sides.

Solution by Nelson L. Roray, Metuchen, N. J.

Let r, R, h and c be the radius of the in-circle, circumcircle and altitude upon the side c respectively of the triangle.

Then we have at once

$$c = \frac{h \sin(A+B)}{\sin A \sin B} \tag{1}$$

$$c = \frac{r \sin \tfrac{1}{2}(A+B)}{\sin \tfrac{1}{2}A \sin \tfrac{1}{2}B} \tag{2}$$

$$c = 2R \sin(A+B) \tag{3}$$

From (1) and (2) we readily obtain

$$\frac{h-2r}{h} = \tan\frac{A}{2}\tan\frac{B}{2}. \tag{4}$$

and

$$\frac{2r}{h}\cos\frac{A}{2}\cos\frac{B}{2} = \cos\tfrac{1}{2}(A+B).$$

$$\frac{c}{r}\cdot\sin\frac{A}{2}\sin\frac{B}{2} = \sin\tfrac{1}{2}(A+B). \qquad \text{[From (2)]}$$

whence

$$\frac{4r^2}{h^2} + \frac{c^2}{r^2}\left(\frac{h-2r}{h}\right)^2 = \frac{1}{\cos^2 A/2 \cos^2 B/2} \tag{5}$$

$$\tan A/2 \tan B/2 = \frac{h}{8R}\left(\frac{1}{\cos^2 A/2 \cos^2 B/2}\right) \qquad (6)$$

From (4), (5) and (6)

$$\frac{4r^2}{h^2} + \frac{c^2}{r^2}\left(\frac{h-2r}{h}\right)^2 = \frac{8R(h-2r)}{h^2}$$

whence

$$c = \frac{2r}{h-2r}\sqrt{2Rh-(4Rr+r^2)}$$

This determines c in terms of r, R, and h and the triangle is easily constructed.

Using (1) and (3) and the well known formula

$r(\sin A+\sin B+\sin C) = 2R\sin A\sin B\sin C$

we easily obtain

$$\sin B = \frac{c(h-r) \pm \sqrt{c^2(h-r)^2-8Rr^2h}}{4Rr}$$

$$\sin A = \frac{c(h-r) \mp \sqrt{c^2(h-r)^2-8Rr^2h}}{4Rr}$$

whence by Law of Sines

$$b = \frac{c(h-r) \pm \sqrt{c^2(h-r)^2-8Rhr^2}}{2r}$$

$$a = \frac{c(h-r) \mp \sqrt{c^2(h-r)^2-8Rhr^2}}{2r}$$

Note: *A solution to 536 was received from* NELSON L. RORAY *too late for publication.—Ed.*

PROBLEMS FOR SOLUTION.

Algebra.

561. *Proposed by the Editor.*
Factor

$$x^2y+x^2z+xy^2+xz^2+yz^2+y^2z+2xyz.$$

562. *Proposed by Murray J. Leventhal, Stuyvesant High School, New York City.*

If n is a prime number, show that $\underline{|n-1}+1$ is a multiple of n.

Geometry.

563. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Using the figure for the Theorem of Pythagoras as given on page 194 of Wentworth's *Plane Geometry* (Edition of 1899), prove

(1) BK, AL and FC are concurrent.

(2) Let X be the intersection of FC and AB, then GX, AD and BC are concurrent.

Prove by means of theorems that are usually given in Book I of plane geometry.

564. *Proposed by N. P. Pandya, Sojitra, B. B. and C. I. Ry., India.*

ABC is a triangle, right-angled at A. AP, AQ are squares on AC, AB, respectively. PB cuts AC at D. QC cuts AB at E. Show that DE is parallel to PQ.

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565. *Proposed by L. E. Lunn, Heron Lake, Minn.*

Prove that the lines joining the vertices of a tetrahedron to the centers of the opposite faces are concurrent at the centeroid of the tetrahedron and are quadrisected at this point. Use only elementary geometry.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

University School, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

Science Tests.

To those who have asked to be enrolled as cooperating on science tests some lists in physics have already been mailed. Chemistry will follow. Suggestions are desired. Returns will be compiled as rapidly as received and communicated to all as quickly as possible.

Additional names received too late for insertion in the March issue: Ira C. Davis, Wisconsin High School, Madison, Wis.; Lynn B. McMullen, State Normal School, Valley City, N. Dak.; Theo. S. Rowland, North East High School, Philadelphia, Pa., H. E. Hammond, Kalamazoo, Mich., Charles J. Pieper and E. L. Harrington, Univ. High School, Chicago, W. A. Hedrick, Central High School, Washington, D. C.

QUESTIONS AND PROBLEMS FOR SOLUTION.

298. *Proposed by G. R. Robertson, Riverside, Cal.*

Why does ammonium hydroxide—a weak, poorly ionized base—attack glass bottles, and what does it do to the glass?

299. *Proposed by O. L. Brauer, Selma, Cal.*

Would the specific heat of a metallic container have any influence on the rate at which it would radiate heat from water within it?

300. *Proposed by J. C. Packard, Brookline, Mass.*

In apartment houses with separate meters, do the people on the top floor get more or less gas for their money? Discuss quantitatively.

301. *Proposed by C. H. Prescott, University School, Cleveland.*

How many calories of heat must be supplied to melt 10 grams of ice?

Is the answer the same when British Thermal Units (B. T. U.) are used? Explain.

Examination Papers.

The receipt of examination papers is gratefully acknowledged from C. T. Beach, Tunkhannock, Pa.; Annie Cloyd, Sewickley, Pa.; R. A. Montgomery, Cushing Academy, Ashburnham, Mass.; H. K. Rhodes, Chambersburg, Pa.; W. F. Roecker, Boys Tech. H. S., Milwaukee, Wis.; W. A. Zinzow, Wausau, Wis.

Please send examination papers on any subject or from any source to the Editor of this department. *He will reciprocate by sending you such collections of questions as may interest you and be at his disposal.* **Send your first term examination now.** If a representative number of papers in physics, chemistry and other sciences can be obtained, the Editor will attempt a comparison of school with college entrance examinations.

Correspondents say they use questions from the papers here published freely in their own examinations. **Do your share now** by slipping *any* (do not wait for all) of your old examination papers into an envelope addressed to Franklin T. Jones, University School, Cleveland, Ohio. Many will be published.

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Biology—December, 1917, Cushing Academy.

Submitted by R. A. Montgomery, Ashburnham, Mass.

I. Define: Zoology, Fertilization, Cell, Leucocytes, Celia, Pericardium, Parasite, Carnivorous, Assimilation.

II. a. Name the different food substances for plant and animal life and give illustration of each.
b. How can you differentiate between living and lifeless things?

III. a. Explain the difference between photo-synthesis and respiration in plants.
b. Name the different parts of a flower.
c. Name the different parts of a typical leaf.
d. Discuss the different methods of pollination.

IV. Locate and state function: Senticel; root cap; ocellus; carotid artery; spiracles; proboscis; ovary; gall bladder; ovipositor; air bladder.

V. Trace the complete circulation of the blood of a frog.

VI. a. Name all external appendages of a fish and compare where possible with the same in a frog.
b. Discuss the life history of a frog from egg to adult.

VII. Discuss the methods of protection: frog, moth, grasshopper, bee, lobster. Discuss honey bees.

VIII. State economic importance of the following: ichneuman fly, lady bug, ants, ground beetles, mosquitos, gypsy moth, Buffalo gnats, Hessian fly, chinch bug, bollweevil.

IX. a. Discuss metamorphosis.
b. Give complete life history of the butterfly.

X. a. Name the different divisions of the thorax of a grasshopper and appendages of each.
b. Discuss protozoa.

General Science—1st Semester, 1918, Chambersburg High School.

Submitted by H. K. Rhodes, Chambersburg, Pa.

(Answer any eight.)

1. Name some bodies composed of copper; paper; stone; iron; rubber. Which of these are organic? Inorganic?

2. A tank is 1 m. deep, 1.5 m. long, 7.5 m. wide. Find its contents in cubic meters.

3. In the laboratory we have two bottles exactly the same in size and capacity; yet one will hold 9 lbs. of sulphuric acid, the other will hold 7 lbs. of nitric acid. Explain this.

4. What are the boiling and freezing points on the C & F scales? Room temperature? Explain why pure acetic acid freezes at 16° C.

5. Name the simple machines. Why are they called machines?

6. Show by a diagram how a double concave lens can remedy near-sightedness.

7. Show by diagram the path of light through a simple periscope. What is the purpose of the periscope?

8. Name two things which are transparent; two which are translucent; two which are opaque. How can the intensity of a light be measured?

9. Write a paragraph on "The Weather Bureau"—what it does, instruments used, maps, etc.

10. Make a diagram of a siphon. Explain fully the use and action of a siphon.

SOLUTIONS AND ANSWERS.

286. *Proposed by John C. Packard, Brookline, Mass.*

Why does the image in a plane mirror, held parallel to the object, appear reversed but not inverted?

Answered by Annie Cloyd, Sewickley, Pa.; R. E. Dooley, Elmer, Okla.; Tracey F. Tyler, Wood River, Neb.; L. E. Lunn, Heron Lake, Minn.; J. E. Running, Ottawa, Ill.

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Answer by R. E. Dooley, Elmer, Okla.

The apparent reversal but not inversion is due neither to the mirror nor any peculiarity of the object, but to our use and understanding of the words "right," "left," "top," "bottom." The following experiment will make the entire matter clear. Put a glove on the left hand (solely for concreteness), call that hand "top" and the right hand "bottom," then call the feet "left" and the head "right." Stand with outstretched arms before a plane mirror and the image will appear "inverted" but not reversed. The illusion is solely in the terms used.

Answer by J. E. Running, Pleasant View Luther College, Ottawa, Ill.

Suppose a person stands facing you. With respect to your own, his position is in reality reversed; that is, his left is towards your right, and his face is turned in the same direction as your back. If this person is now commanded to "about face" his right will be towards your right and his face turned in the same direction as your face. Suppose now that all but his very front surface became invisible, you would then see his front surface facing away from you, but to you he would appear to be turned towards you because your experience has taught that you can see a person's front only when it is turned towards you. Your image in the mirror is that of your front surface facing in the same direction as you are facing and with the rest of the body eliminated. Consequently, your image is not reversed as it appears.

289. *From an examination paper of Anglo-Chinese College.*

If a burner can heat 2 kg. of water from 10° to 80°C. in 10 minutes how much water can it boil away into steam in one hour?

Solved by Annie Cloyd, L. E. Lunn.

Solution by Annie Cloyd, Sewickley, Pa.

Heat necessary to vaporize 1 gm. of water = 536 cal.; to vaporize 1 kgm. of water, 536,000 cal.

Burner gives heat at rate of $2000 \times 70 \div 10 = 14{,}000$ calories per min.

In 60 min. $60 \times 14{,}000 = 840{,}000$ cal.

$840{,}000 \div 536{,}000 = 1.567$ kgm. of water would be vaporized.

290. *From an examination paper of Boston University.*

If 2 gm. of potassium chloride yield 3.84 gm. of silver chloride, what is the atomic weight of potassium?

(Note.—At. wts.: Hg = 200.5, Ag = 108, Cl = 35.5.)

Solution by Annie Cloyd.

$KCl + AgNO_3 \longrightarrow AgCl + KNO_3$

$x + 35.5 \qquad 108 + 35.5$

2gm. 143.5

3.48 gm.

$$\frac{x + 35.5}{2} = \frac{143.5}{3.48}$$

$x = 39.2$ atomic weight of potassium.

294. *From "An Elementary Study of Chemistry," by McPherson and Henderson (Ginn & Company, 1917).*

The heat evolved in the slacking of 100 kg. of lime would raise the temperature of what weight of water from room temperature (say 18°) to boiling?

Solved by Joseph Rokke, Alexandria, Minn, and S. F. Davis.

Solution by S. F. Davis, John Tarleton Ag. Col., Stephanville, Tex.

$CaO + H_2O = Ca(OH)_2 + 15{,}540$ cal.

In other words, one gram molecular weight (56 gms.) of CaO will produce 15,540 calories of heat.

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Bacon long ago mentioned the need of "A Calendar of Leading Experiments for the better interpretation of nature," and the authors have borrowed from Bacon the title of this book *On Lecture-room Experiments in Physics.*

Most of the experiments as described are very simple and most of the apparatus required is inexpensive, and the authors believe that the book will be very helpful to the teacher of physics in the High School.

An important feature of the book is an Appendix on *A Visitors' Laboratory of Physics* in which suggestions are made for the setting up permanently of about 80 experiments for the edification of visitors. The authors believe that this phase of the museum idea should be developed in every High School.

Another feature of the book is an extremely simple and clear setting forth of the fundamental ideas of mechanics; and the authors make use of every opportunity to illuminate the problems of the teacher, and they do this in a way that will certainly entertain the reader and, as the authors believe, also edify him.

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$\frac{15,540}{56}$ = 277.5 cal. produced from the slacking of one gram.

$277.5 \times 1000 \times 100$ = 27,750,000 cal. from 100 kg.

$100° - 18°$ = 82° temperature interval through which the water would be raised.

$\frac{27,750,000}{82}$ = 338,414 grams of water which would be raised from 18° to boiling.

THE PRESIDENT'S DEFINITION OF GERMANISM.

Innumerable articles and many books have been written to define "Germanism" and show to the world what it means.

In his message to Congress, December 4, President Wilson defines it as follows:

"This intolerable Thing of which the masters of Germany have shown us the ugly face, this menace of combined intrigue and force which we now see so clearly as the German power, a Thing without conscience or honor or capacity for covenanted peace."

This Thing must be crushed, and if not truly brought to an end, at least shut out from the friendly intercourse of the nations, says the President, and it is only when this Thing and its power are indeed defeated that the time can come when we can discuss peace with the German people.

MEETING OF THE ASSOCIATION OF TEACHERS OF SECONDARY MATHEMATICS OF NORTH CAROLINA.

This meeting was held at Greensboro, February 1 and 2. A popular lecture on "The Origin of Mathematics," a somewhat more technical one on "Deficiencies in Present Preparatory Mathematics," and a round table discussion on the topic "A Proper Approach to Elementary Mathematics" were the contributions of the chief speaker, Dr. David E. Smith. Papers were presented to the Association by Miss Fannie Starr Mitchell, of the Raleigh High School, Mr. J. W. Lasley, Jr., of the University of North Carolina, Miss Virginia Ragsdale, of the Normal College, and Miss Ella Bradley, of the Gastonia High School.

The following officers were elected: Mr. W. W. Rankin, Jr., of the University of North Carolina, President; Mr. S. L. Sheep, of the Marion High School, First Vice-President; Miss Maria Graham, of the Eastern Carolina Training School, Second Vice-President; Miss Nita Gressitt of the Greensboro High School, Third Vice-President; Mr. J. W. Lasley, Jr., Secretary.

The Mathematics Club of the University of North Carolina held an informal smoker on the night of Wednesday, February 6. A paper on "A Method for Finding the Complex Roots of a Cubic Equation" was presented to the club by Mr. J. W. Lasley, Jr., of the department of mathematics. A noteworthy feature of this meeting of the club was the presence of certain of the best men in the freshman class. To interest these men at the outset of their college career and to get into a closer touch with them than the classroom affords are among the aims of the organization.

Strangling the Periodicals

Congress at its last session passed a hasty postal law increasing the postage on periodicals from FIFTY TO NINE HUNDRED PER CENT.

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Thus to shut out farm journals—as these zone rates will—will lessen the productive power of our country by millions of dollars through loss of better methods. Shut off trade journals and you decrease the manufacturing power by more millions. Shut off the religious papers and there are shut off channels that have raised millions of dollars for distressed humanity. Shut off the great periodicals of the home and there is throttled an avenue that has given expert instruction to hundreds of thousands of mothers and saved their babies to health and citizenship.

These national periodicals are printed in the big cities—and the first zone, the cheapest zone, is in or near those cities; there are many educational opportunities near cities, and the cities will read anyway. Small towns and distant districts depend to a large extent upon periodicals; thus this law increasing postage where it is most needed shuts off opportunity where needed. It penalizes periodical readers.

Repeal this law. Repeal this FIFTY TO NINE HUNDRED PER CENT periodical postage increase. Sign the petition below and mail it. Put a cross mark in the square—save the periodicals and the work that they have done and are doing for national education and patriotism.

PETITION TO CONGRESS—Sign Here!

The spread of education, of culture, of scientific knowledge and advancement, and of our vast internal merchandising and manufacturing has been, and always is, vitally dependent upon the freest and cheapest circulation of periodicals. The penalties resulting from any restriction on the freest possible circulation of periodicals will be destructive of the best interests of our economic life and the opportunities of developing our best citizenship.

The postal amendment passed by the last Congress increasing the postage on periodicals from FIFTY TO NINE HUNDRED PER CENT will throttle or destroy our periodicals at a time when the widest and most extensive circulation of publications is essential to the patriotism, education, and upbuilding of our country.

Therefore, I the undersigned, do most earnestly demand the repeal of this burdensome periodical postage amendment.

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Selling some billion and a half board feet of timber and supervising the cutting on several thousand different areas, overseeing the grazing of more than 1,500,000 cattle and 7,500,000 sheep, and building more than 600 miles of road, 2,000 miles of trail, 3,000 miles of telephone line, and 700 miles of fire line, are some of the things which the Government Forest Service did last year, as disclosed in the report by the Chief Forester for 1914. These activities were all on the national forests, which at present total about 185,000,000 acres.

There is need, says the Chief Forester, to increase the cut of timber from the national forests wherever a fair price can be obtained for the stumpage, because a great deal of it is mature and ought to be taken out to make room for young growth. Unfavorable conditions in the lumber trade caused new sales of national forest timber to fall off somewhat during the past year, though the operations on outstanding sales contracts brought the total cut above that of the previous year by 130,000,000 board feet. There was, however, a big increase in small timber sales, these numbering 8,298 in 1914 against 6,182 the previous year. Desirable blocks of national forest timber have been appraised and put on the market, and it is expected that these will find purchasers when conditions in the lumber industry improve.

After eight years of experience, stockmen are well satisfied, says the chief forester, with the way the grazing of live stock on the forests is regulated, and have even urged upon Congress the application of the same method of control to the unreserved public range. Almost 29,000 permittees graze stock on the national forests, and these paid to the Government in the fiscal year 1914 fees amounting to over a million dollars. The present tendency to raise fewer sheep and goats and more cattle and horses is shown in the fact that the number of cattle and horse permittees on the western forests increased last year by 1,579, while the number of sheep and goat permittees fell off by a total of 268.

Under another law, twenty-five per cent of the national forest receipts for the year, amounting to $586,593.39, were paid over to the various states in which the forests lie for the benefit of county schools and roads.

Since 1909, when systematic classification of national forest lands was begun, more than 10,000,000 acres have been eliminated. Scattered interior tracts which it is not practical to eliminate are opened to settlement through listing, which allows them to be taken up under the forest homestead law. Anyone may apply to have land within a forest examined to determine whether it is best suited for agriculture, and if found so it is opened to settlement under this law. During the year 2,690 tracts, totaling 282,483 acres, applied for by individuals, were opened for entry. By elimination and listing, the percentage of unpatented agricultural land within the national forests, never lare, has been reduced to a very small amount.

ARTICLES IN CURRENT PERIODICALS.

American Botanist, for February; *Joliet, Ill.; $1.25 per year, 35 cents a copy:* "Odorous Flowers of Texas," Cecilia A. Middlebrook; "A Botanist's Suggestion for a National Flower," E. F. Andrews; "A Pollinating Contrast," Albert A. Hamen; "Food from Wild Plants."

American Journal of Botany; Brooklyn Botanic Garden, Brooklyn, N. Y.; $5.00 per year, 60 cents a copy: "The Influence of Illuminating Gas and Its Constituents on Certain Bacteria and Fungi," C. A. Ludwig; "A Bacteriological Method Useful for the Study of Other Microorganisms," Freda M. Bachmann; "The Development of Some Exogenous Species of Agarics," Gertrude E. Douglas.

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American Mathematical Monthly, for January; *27 King St., Oberlin, Ohio; $3.00 per year:* "Bibliographical Notes on the Use of the Word 'Mass' in Current Text Books," Edward V. Huntington; Problems and Solutions.

Educational Administration and Supervision; Hershey, Pa.; $2.50 per year, 40 cents a copy: "The Administration of Public Education in War Times," George Drayton Strayer; "The War and the Curriculum of the Public Schools," Lotus D. Coffman; "The War and Secondary Education," Alexander Inglis; "The War and Vocational Education," David Snedden; "The War and Methods of Instruction," W. W. Charters; "The Training of Teachers as a Phase of Democracy's Educational Program," W. C. Bagley.

Journal of Educational Psychology, for January; *Lancaster, Pa.; $3.00 per year, 35 cents a copy:* "Some Mathematical Aspects of the Binet-Simon Tests," Francis N. Maxfield; "The Measurement of Intelligence: Six Hundred and Fifty-three Children Examined by the Binet and Porteus Tests," S. D. Porteus; "Freshman Tests at the State University of Iowa," Irving King and James M'Crory.

Journal of Geography, for March; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "Agriculture on the Nile Delta," V. C. Finch; "Russia in War Time" (Reprinted), H. V. Winchell; "Pronunciation of Certain Place Names," R. M. Harper; "Streets of Cities," Frederick Homburg; "Supplementary Work in the Teaching of Geography," E. S. Clem.

Nature-Study Review, for February; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Science and Nature-Study," S. C. Schmucker; "The Spirit of Nature-Study," Cora A. Smith; "The Correlation of Nature-Study in the Platoon School," Julia Shourek; "Some Mechanical Aids in Nature-Study," Wm. G. Vinal; "The Opportunity for Research in the Problems of Teaching Nature-Study," Elliott R. Downing.

Popular Astronomy, for March; *Northfield, Minn.; $3.50 per year:* "A Unique and Famous French Observatory," Charles Nevers Holmes; "A New Form of Mounting for Large Reflectors," Russell W. Porter; "What Was the Star of Bethlehem?" Stansbury Hagar; "Relativity in Astronomy," W. Carl Rufus; "On Selecting Stations for Totality of 1918, June 8, and Probable Cloud Conditions at Eclipse Time," David Todd; "Eclipse Stations in Oregon and Washington," Sydney D. Townley; "A Simple Plan for Unifying Time in the United States," Jermain G. Porter; "Report of the American Meteor Society for 1917," Charles P. Olivier.

Physical Review, for February; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy:* "The Brightness Sensibility of the Retina," Julian Blanchard; "The Moment of Momentum Accompanying Magnetic Moment in Iron and Nickel," John Q. Stewart; "A Study of the Fluorescence of Certain Uranyl Salts at Room Temperature," Frances G. Wick; "Proceedings of the American Physical Society."

Teachers College Record, for January; *Teachers College, New York City; $1.50 per year, 40 cents a copy:* "Schools in War Time and After," Arthur D. Dean; "Practical Arts in General Education," David Snedden; "School Statistics for the Public," Carter Alexander; "Games Involving Number," Louise S. Steinway; "Value of Household Arts Education," Frederick G. Bonser; "High Standards of Living at Low Cost," Anna S. Matthews; "Tested International Recipes," May B. Van Arsdale and Others.

DO YOU HAVE SUPERVISED STUDY IN PHYSICS?

Inasmuch as I have been asked to discuss in some detail the problem of supervised study in physics at the coming spring meeting of the Conference of Affiliated Schools with the University of Chicago, may I urgently request every teacher who has tried supervised study in physics classes to send me *at once* a definite and comprehensive statement as to the result of the experiment? Due recognition in the report and in the account to be published later in this magazine will be given those who promptly comply with this request. Address E. L. Harrington, School of Education, University of Chicago.